MANUAL OF PUBLIC HEALTH

HYGIENE

BY

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THIRD EDITION

With 212 Illustrations and
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PREFACE TO THE THIRD EDITION

THE few short years which have intervened between this Third Edition and its predecessor were full of happenings as our Country swung over from a state of War to the constructive ideals of the post-war *régime.* Especially in the world of Medicine there have been momentous changes, much too arresting to be treated merely in outline. We felt that the occasion demanded not only a wider field but also a fuller one, by a more comprehensive treatment of our subject matter. So we have written, and the Third Edition grew.

The book has undergone a complete revision and been enlarged in consequence. Vital statistics now features Biometrics and has been expanded to cover statistical methods, including graphical presentation and the Chi-square test. The section on Food now presents current legislation on milk, together with a new article on the inspection of dairies and other food premises.

The environmental aspects of the book have been developed up to post-graduate standard. Specimen analyses and field tests have been added to the section on Water Supply, while notes on prefabrication, design, and inspection of dwellings now figure under Housing. The section on Infestation has been extended to deal fully with modern methods of pest control, including the contact insecticides, and the community aspects of the pathogenic fungi.

The section on International Health Relations deals *in extenso* with Aircraft Regulations. New sections are those on Health Education and Medical Climatology. The concluding section bears the title Social Vista. Beginning with Social Medicine, it pictures in succession, among other topics, the Poor Law, Medical Practice, Unemployment, Orthopaedics, the National Health Service Act and the Care of Aged Persons.

One hundred and twenty-two new figures and thirty new tables have been added and four plates in colour inserted.

The book now covers the ground of the Certificate and Diploma examinations in Public Health, and will be found more than adequate for undergraduate courses in preventive and social medicine. We trust that it may also prove useful for reference to Medical Officers of Health, Sanitary Inspectors and other workers in kindred fields.

D. P. Cuthbertson, M.D., D.Sc., now Director of the Rowett Research Institute, has kindly added what is new since 1944 to enrich his articles on Nutrition and Dietaries.

It is a pleasure to thank Professor Thomas Ferguson for his perusal of our Industrial Hygiene, and Professor Emeritus James Drever for advice on the tangled theme of intelligence tests. To Professor John Ryle we are indebted for the quotation which ushers in our social section.

In the province of sanitation we are obliged to Mr. John Innes, Chief Sanitary Inspector of the Burgh of Paisley, for his views on waste disposal. We have incorporated in the text his notes on right ways of inspecting houses, food stores, dairies and similar premises.

Our friends in the public services have, as in previous years, stood us in good stead. Our acknowledgments for figures permitted to be used are made in the list of illustrations and elsewhere. We are again indebted to our publishers for their competent handling of difficult material and for the general excellence of their production.

J. R. C.
A. G. M.

THE UNIVERSITY, GLASGOW,
May, 1948.

PREFACE TO THE FIRST EDITION

This volume on Hygiene is intended for the use of students of medicine. It may be of interest also to medical graduates or licentiates engaged in general practice. Administrative and legal points, except where they bear directly on the doctor's own work or the welfare of his patients, have therefore not been elaborated.

In the arrangement of the material priority has been given to the social aspects of Hygiene. After the General Survey of Section I the attempt is made to follow the individual, in his relation to the social services, from his inheritance in Section II through his prenatal and infant existence, his young childhood and his school years to his active working life and finally, in section VII, his old age. The subject of Food occupies Section X. Then come the environmental services and, beginning with Section XIX, Infection and Infestation. The concluding section has to do with international health relations.

It is a pleasure to thank my colleagues E. P. Cathcart and E. Hindle for reading my articles on Dietaries and Genetics, and to say that I am indebted to Dr. John J. Buchan, Medical Officer of the City of Bradford, for his valued guidance on English procedure. I am obliged to Dr. G. L. Pillans, Home Office Instructor, for the substance of what is said on Air Raid Precautions, and to Dr. R. C. Gray of this University and my friends in the Public Services for views kindly expressed on questions arising. Dr. A. G. Mearns of the Institute supplied material for School Hygiene and Community Diseases, made the new line drawings and aided the production of the book in other ways.

My acknowledgments for figures permitted to be used are made in the List of Illustrations. My publishers, as always, have been patient and obliging.

J. R. CURRIE.

Institute of Hygiene,
The University, Glasgow,
July, 1938.

CONTENTS

SECTION PAGE

I. GENERAL SURVEY 1
Down the Centuries. Preventive Idea. Humanism. Further Progress. Hygiene Today. Public Health.

II. INHERITANCE 7
Genes. Chromosomes. Sex-linked Inheritance. Autosome Inheritance. Mendelian Ratio. Mutation. Lethal Factors. Environment. Eugenics.

III. MATERNITY AND CHILD WELFARE . . . 19
Domestic Services. Institutional Services. Prevention of Maternal Death and Morbidity. Prevention of Prenatal Death. Neonatal Death. Prevention of Infant Death. Welfare of Pre-school Children. Child Protection. Adoption. Employment. Foster Children.

IV. SCHOOL HYGIENE 43
Education Acts. School Premises. Medical Inspection. Treatment. Disability. Welfare. Home Influence. School Meals. Open-air Teaching. Choice of Employment.

V. MENTAL HYGIENE 66
Mental Deficiency. Mental Tests. Grades. Germinal Causes. Sterilisation. Extraneous Causes. Control of Mental Defectives. Social Adjustment. Other Mental Disorder. Mental Treatment Act.

VI. INDUSTRIAL HYGIENE 81
Factory Conditions. Health Provisions. Safety Provisions. Special Provisions. Industrial Welfare. Welfare Schemes. Industrial Nurses. Canteens. Likes and Dislikes. Fatigue. Rehabilitation. Disabled Persons (Employment) Act. Industrial Poisoning. Metallic Poisons. Non-Metallic Poisons. Gaseous Poisons. Industrial Disease. Anthrax. Chrome Ulceration. Epitheliomatous Ulceration. Silicosis. Asbestosis. Other Dust Effects. Dermatosis. Caisson Disease. Deep Sea Diving. Notifiable Industrial Diseases. Examining Surgeon. Mines. Workmen's Compensation.

VII. PUBLIC HEALTH ADMINISTRATION . . . 118
Minister of Health. Local Authorities. Legislation. Public Health Act, 1936. Public Health Officials. Scottish Administration. Local Government (Scotland) Act, 1929.

VIII. STATISTICS 145
Census. Estimates of Population. Births. Birth Rate. Trend. Family Allowances Act, 1945. Marriages. Deaths. Registration. Death Rates. Direct and Indirect Methods. Occupational Mortality. Males. Wives. Single Women. Life Tables. Biometrics. Statistical Constants. Centring Constants. Dispersion Constants. Standard Deviation. Grouped Frequency Distribution. Graphical Presentation. Continuous Variables. Graphs. Histogram. Frequency

SECTION PAGE

Curve. Skewness. Frequency Polygon. Integral Frequency Curve. Normal Frequency Curve. Probable Error. Discontinuous Variables. Time Trend Diagram. Arithlog Ruling. Smoothing. Correlation. Regression. Sampling and Method. Chi-square Test.

IX. FOOD 211

Nutrition. Protein. Fat. Carbohydrate. Mineral Substances. Vitamins. Water. Dietaries. Food Control. Milk. Genuine Milk. Adulteration. Clean Milk. Safe Milk. Milk and Dairies Orders, 1926-1938. Milk-Borne Diseases. Designated Milks. Tuberculin Test. Pasteurisation. Milk Derivatives. Meat. Slaughter. Slaughter Houses. Enzootic Diseases. Meat Control. Meat Products. Horse Flesh. Rabbits and Hares. Poultry. Eggs. Fish. Shell Fish. Crabs. Lobsters. Oysters, Mussels. Cockles. Cereals. Other Vegetable Foods. Cooking. Communal Feeding. Beverages. Other Foods. Food Preservation. Refrigeration. Gas Storage. Canning. Chemical Preservatives. Food Poisoning. Plant Sources. Animal Sources. Metals. Chemical Poisons. Allergy. Bacterial Food Poisoning. Botulism. Inspection of Food-Preparing Premises. Food Shops.

X. VENTILATION 289

Vitiated Air. Katathermometer. Air Delivery. Air Change. Room Dimensions. Natural Ventilation. Artificial Ventilation. Agitator Fans. Testing of Ventilation.

XI. WARMING 301

Coal Fire. Stove. Gas Fire. Electricity. Hot Water. Steam. Hot Air. Smoke. Atmospheric Pollution. Legislation.

XII. LIGHTING 313

Light Measurement. Lighting Standards. Sunlight. Natural Lighting. Artificial Lighting. Glare.

XIII. WATER SUPPLY 320

Sources. Rain Water. Surface Water. Upland Water. Streams. Lakes. Rivers. Ground Water. Springs. Wells. Quantity. Distribution. Water-borne Disease. Characters of Water. Testing of Water. Chemical Tests. Field Work. Bacteriological Tests. Purification of Water. Filtration. Chlorination. Other Chemical Methods. Irradiation. Softening. Purification of Mains. Domestic Purification. Swimming Baths.

XIV. WASTE DISPOSAL 342

Dry Refuse. Sewage. Combined System. Fixtures and House Pipes. Traps. House Drains. Drain Tests. Sewers. Separate System. Conservancy System. Camp Waste. Direct Disposal. Sewage Purification. Standard for Effluents. Preliminary Processes. Completing Processes. Chlorination. Storm Water. Sewage Disposal. Garchey System. Rivers Pollution. Riverine Life. Self-Purification. Limit of Safe Loading. Admission of Trade Wastes. Results. Prospects.

SECTION PAGE

XV. HOUSING 364
Aspect. Surroundings. House Construction. Damp. Interior Arrangement. Insanitary Houses. Overcrowding. Inspection of Houses. Rehousing. Post-War Housing. Prefabrication. Design of Dwellings. Town and Country Planning. Post-War Planning. New Towns Act, 1946.

XVI. HOSPITALS 384
General Hospitals. Isolation Hospitals. Sanatoria. Mental Hospitals. Nursing Homes. Nurses. Almoners.

XVII. INFECTION 399
Bacterial Infection. Incubation. Carrier State. Protozoan Infection. Virus Infection. Source of Infection. Path of Infection. Portal of Entrance. Immunity. Serum Disease. Protozoan Immunity. Virus Immunity. Prevalence. Propinquity Diseases. Season. Epidemiology.

XVIII. PREVENTION 416
Diagnosis. Notification. Treatment. Isolation. Home Isolation. Hospital Isolation. Isolation Period. Quarantine. Contacts. Carriers. Immunoprophylaxis. Disinfection. Disinfectants. Steam Heat. Dry Heat. Other Methods. Concurrent Disinfection. Terminal Disinfection. Air Disinfection. Disposal of the Dead.

XIX. COMMUNITY DISEASES 437
Actinomycosis. Beriberi. Bornholm Disease. Cancer. Cerebrospinal Fever. Chicken Pox. Cholera. Dengue. Dental Fluorosis. Diphtheria. Dysentery Amoebic. Dysentery Bacillary. Dysenteries Other. Encephalitis Lethargica. Endemic Goitre. Epidemic Enteritis. Epidemic Hepatitis. Ergotism. Erysipelas. Foot and Mouth Disease. German Measles. Glanders. Glandular Fever. Heat Stroke. Hook Worm Disease. Hydrophobia. Infective Coryza. Infective Jaundice. Influenza. Leishmaniasis. Leprosy. Malaria. Measles. Mumps. Pellagra. Plague. Pneumonia. Poliomyelitis. Psittacosis. Rat Bite Fever. Relapsing Fever. Rheumatism. Rickets. Sand Fly Fever. Scarlet Fever. Scurvy. Smallpox. Tetanus. Trachoma. Trench Fever. Trypanosomiasis. Tuberculosis. Tularaemia. Typhoid Fever. Typhus Fevers. Undulant Fevers. Venereal Disease. Vincent's Angina. Whooping Cough. Yaws. Yellow Fever.

XX. INFESTATION 523
Helminthes. Platyhelminthes. Fasciola. Fasciolopsis. Clonorchis. Paragonimus. Schistosoma. Taenia. Echinococcus. Diphyllobothrium. Nemathelminthes. Ascaris. Enterobius. Ankylostoma. Necator. Wuchereria. Oncocerca. Loa Loa. Dracunculus. Trichinella. Trichiniasis. Arthropoda. Insecta. Thysanura. Collembola. Orthoptera. Blatta. Periplaneta. Anoplura. Pediculus. Body Louse Disinfestation. Head Louse Disinfestation. Phthirus. Crab Louse Disinfestation. Rhynchota. Cimex. Conorrhinus. Bug Disinfestation. Lepidoptera. Tinea. Sitotroga. Pyralis. Ephestia. Plodia. Tenebrio. Tribolium. Bruchus. Calandra. Dermestes. Anobium. Xestobium. Niptus. Diptera. Psychodidae. Phlebotomus. Culicidae. Culicine Mos-

SECTION PAGE

quitos. Anopheline Mosquitos. Mosquito Control. Simuliidae. Simulium. Tabanidae. Tabanus. Haematopota. Chrysops. Anthomyidae. Homalomyia. Musca. House Fly Repression. Calliphora. Lucilia. Stomoxys. Glossina. Myiasis. Pulicidae. Pulex. Xenopsylla. Ceratophyllus. Flea Disinfestation. Tunga. Hymenoptera. Mutilla. Monomorium. Arachnida. Dermatocentor. Ixodes. Argas. Ornithodorus. Leptus. Trombicula. Sarcoptes. Scabies. Tyroglyphidae. Contact Insecticides. D.D.T. Gammexane. Laboratory Diagnosis of Parasites. Filthy or Verminous States. Rats and Mice. Rat Infections. Rat Control. Rats and Mice (Destruction) Act.

XXI. PERSONAL HYGIENE 582
Use of Air. Use of Water. Discretion in Diet. Alcohol. Tobacco. Clothing. Footwear. Posture. Exercise. Physical Training. Later Years. Noise.

XXII. HEALTH EDUCATION 590
Councils. Prolegomena. Schools. Propaganda. The Press. Leaflets. Brochures. Posters. Health Lectures. Cinematograph. Wireless Broadcasting. Health Exhibitions. Open Air Displays. Health Weeks. Scheme of Public Education in Health.

XXIII. METEOROLOGY 613
Pressure. Barometers. Pressure Unit. Kew Pattern Barometer. Fortin Barometer. Pressure Variation. Isobars. Winds. Wind Velocity. Beaufort Scale. Planetary Winds. Cyclones. Origin. Tropical Cyclones. Tornados. Line Squalls. Local Winds.

XXIV. MEDICAL CLIMATOLOGY 626
Zone Types. Polar. Westerlies. Horse Latitudes. Trade Winds. Equatorial Zone. Continental Types. Plains. Plateaux. Mountains. Marine Types. Ocean. East Coast. West Coast.

XXV. INTERNATIONAL HEALTH RELATIONS . . . 641
International Hygiene. Sea Ports. Rats on Shipboard. Imported Food. Passenger Ships. Air Ports. Aircraft. Public Health (Aircraft) Regulations (Scotland) 1946. Aircraft Arriving. Aircraft Departing. Schedules of Procedure.

XXVI. THE SOCIAL VISTA 655
Social Medicine. Post-Graduate Teaching. Poor Law of England. Public Assistance. Medical Practice. Peckham Experiment. Ministry of National Insurance. National Health Insurance. Contributory Pensions. Old Age Pensions. Unemployment Insurance. Unemployment Assistance. Care of the Blind. Orthopaedics. National Insurance Act, 1946. National Insurance (Industrial Injuries) Act, 1946. National Health Service Act, 1946. Education (Scotland) Act, 1946. Medico-Social Problems of the Aged.

INDEX 697

LIST OF ILLUSTRATIONS

FIG. PAGE

1. CHROMOSOMES 7
2. MITOSIS 8
3. SEX-LINKED INHERITANCE 10
4. THE HAPSBURG LIP 11
5. MENDELIAN RATIO 12
6. PEDIGREE SYMBOLS 17
7. SAMPLE PEDIGREE 18
8. MOTHERCRAFT CLASS 34

   This and Nos. 10, 11, 17, 19, 20, 21, 97, 98 and 130 from *Child and Adolescent Life in Health and Disease by W. S. Craig.* By kind permission of Messrs E. & S. Livingstone.

9. PLAY ROOM, DAY NURSERY 36

   This and Nos. 15 and 16 by kindness of the Corporation of Glasgow.

10. HAND WASHING SUPERVISION, DAY NURSERY 38
11. TOILET REQUISITES, NURSERY SCHOOL 39
12. SCHOOL BUILDINGS DESIGNS 45
13. MODERN PRIMARY SCHOOL 46
14. DESKS 48
15. ACTINOTHERAPY ROOM 51
16. DENTAL CLINIC 52
17. TEACHING BY BRAILLE SYSTEM 54
18. LIP READING 55

    From *The Handicap of Deafness* by I. R. and A. W. G. Ewing. By kind permission of Messrs. Longmans, Green & Co., and courtesy of the Committee and Headmaster of the Royal Residential Schools for the Deaf, Manchester.

19. RELAXATION THERAPY FOR STAMMERING 56
20. REMEDIAL SWIMMING BATH 57
21. OPEN AIR SCHOOL 65
22. COLD AIR DOUCHES 83

    This and No. 27 by kindness of the Sturtevant Engineering Co., London.

23. TOXIC HEPATIC NECROSIS 97

    By kindness of Professor Glaister.

24. CHLORACNE OF FACE 98

    This and Nos. 26, 28 and 29 by kindness of Dr. Edward Collier, Medical Officer, Messrs. Rolls, Royce Ltd.

25. MALIGNANT PUSTULE 102
26. CHROME ULCER 103
27. LOCAL EXHAUSTS IN GRINDING SHOP 106
28. OIL DERMATITIS 109
29. PARAFFIN DERMATITIS 110
30. POPULATION TREND 152
31. KEY PUNCH 172

    This and No. 32 by kindness of Messrs. Powers-Samas Accounting Machines Ltd.

32. MECHANICAL SORTER 173
33. CO-ORDINATES OF GRAPH 183
34. CONSTRUCTION OF GRAPHS 184

FIG. PAGE
35. HISTOGRAM 185
36. SKEWNESS 187
37. FREQUENCY POLYGON 188
38. INTEGRAL FREQUENCY CURVE 189
39. GALTON'S QUINCUNX 190
40. SYMMETRICAL CURVE 191
41. BAR DIAGRAM 193
42. SECTOR DIAGRAM 194
43. SPOT MAP 195
44. TUBERCULOSIS: INCIDENCE 196
45. TIME TREND: ARITHMETICAL RULING 197
46. TIME TREND: ARITHLOG RULING 198
47. SMOOTHING BY MOVING AVERAGES 200
48. SMOOTHING BY LEAST SQUARES 201
49. REGRESSION 205
50. COWSHED 233
By kindness of Miss J. A. Hogarth of Strowan.
51. MILK CARTON 244
52. CAPTIVE BOLT PISTOL 250
By kindness of Messrs. Accles & Shelvoke, Birmingham.
53. NORTH BRITISH 'QUICKSTUN' APPLICATOR 251
By Kindness of the North British Lifting and Moving Appliance Co., Glasgow.
54. ADVANCED TUBERCULOSIS OF COW 254
From *Food Inspection* by H. A. Macewen. By kind permission of Messrs. Blackie & Son, London.
55. FOOD MICROSCOPY 262
56. FOOD MICROSCOPY 263
57. FOOD CANS 275
58. KATATHERMOMETER 291
59. NATURAL VENTILATION 296
60. VENTILATION INLETS 297
61. McKINNELL'S ROOF VENTILATOR 298
62. PLENUM SYSTEM 299
63. HIGH PRESSURE HOT WATER SYSTEM 305
64. HOT WATER RADIATOR AT WINDOW 306
65. OWEN'S AUTOMATIC AIR FILTER 308
This and No. 66 by kindness of Messrs. C. F. Casella, London.
66. OWEN'S SMOKE EMISSION METER 309
67. FULHAM POWER STATION 310
68. ELECTRIC LAMPS 316
This and Nos. 75, 90, 102, 103, 182, 192 and 193 are original photographs by W. J. Elsey.
69. LIGHTING METHODS 317
70. IMPOUNDING RESERVOIR: ELAN VALLEY 32
By kind permission of Birmingham Water Department.
71. PROTECTED SPRING 32
72. PROPERLY CONSTRUCTED WELL 32
73. FAULTY WELL 32
74. VENTURI METER [illegible]
75. BACTERIOLOGICAL WATER-SAMPLING BOX 3

FIG. PAGE
76. ALGAE 332
77. ALGAE 333
78. SLOW SAND FILTER 335
79. PRESSURE FILTERS 336
By kindness of Messrs. Bell Bros., Manchester.
80. ULTRA-VIOLET RAY STERILISATION OF WATER 337
From *Hygiene and Public Health* by Kenwood and Kerr. By kind permission of Messrs H. K. Lewis & Co., London.
81. DOMESTIC FILTER: BERKEFELD TYPE 339
By kindness of Messrs Doulton & Co., London.
82. SWIMMING BATH: CONTINUOUS RECIRCULATION . . . 340
83. P AND S TRAPS 345
84. HOUSE PIPES 346
85. IMHOFF TANK 352
86. TRAVELLING DISTRIBUTOR: FIDDIAN TYPE 355
By kind permission of Messrs Jones & Attwood, Ltd., Stourbridge.
87. GARCHEY SYSTEM: COLLECTION 358
88. GARCHEY SYSTEM: DISPOSAL 359
89. FOOTING OF WALL 365
90. DRY ROT 367
91. MODERN FLATS 374
By kindness of Messrs. Ascot Gas Water Heaters, Ltd., London.
92. ARCON BUNGALOW 376
93. TARRAN BUNGALOW 377
94. PLAN FOR GREATER LONDON 381
95. NURSES' HOME 387
This and No. 96 by courtesy of the Corporation of Paisley.
96. CUBICLE ISOLATION BLOCK 388
97. ISOLATION CUBICLES IN SERIES 389
98. DETAIL OF ISOLATION CUBICLE 390
99. MODERN SANATORIUM 391
This and Nos. 125 and 129 from *Manual of Tuberculosis for Nurses*, by E. A. Underwood. By kind permission of Messrs. E. & S. Livingstone.
100. EPIDEMIC CURVE 407
101. HERD IMMUNITY 412
102. ALFORMANT LAMP 428
103. MACKENZIE SPRAY 429
104. DISINFECTING STATION 431
By kindness of Messrs. Manlove, Alliott & Co., Nottingham.
105. WEST'S POST-NASAL TUBE 440
106. CHICKEN POX 442
This and Nos. 107, 108 and 121 from the original drawings in possession of the Wellcome Foundation, Ltd., by kind permission.
107. SCHICK TEST 446
108. SCHICK TEST 447
109. ENTAMOEBA HISTOLYTICA AND CYST 450
110. GIARDIA LAMBLIA 452
111. BALANTIDIUM COLI 453
112. RABID DOG 461
113. LEISHMANIA DONOVANI 465
114. LIFE CYCLE OF P. VIVAX 467

FIG. PAGE

115. MALARIAL PARASITES 469

This and Nos. 116, 169 and 179 from Manson-Bahr's *Tropical Diseases.* By kindness of Messrs. Cassell, London.

116. BLOOD PICTURES IN MALIGNANT TERTIAN MALARIA 471

117. MUMPS 473

From Manual of Fevers by C B. Ker. By kindness of the Oxford University Press.

118. PELLAGRA 474

This and No. 190 from *Introduction to Dermatology* by G. H. Percival. By kind permission of Messrs. E. & S. Livingstone.

119. COMBINAISON HERMÉTIQUE 476

120. RICKETS 482

From *Diseases of Children* by Bruce Williamson. By kind permission of Messrs. E. & S. Livingstone.

121. SCARLET FEVER 485

122. SMALLPOX 488

This and No. 123 from original photographs by Dr. Alexander MacLean, reproduced by permission of the Corporation of Glasgow.

123. HANDS IN SMALLPOX 489

124. TRYPANOSOMES 494

125. TUBERCLE BACILLI IN SPUTUM 497

126. SURGICAL TUBERCULOSIS BEFORE ALPINE TREATMENT 498

This and No. 127 after Rollier.

127. SURGICAL TUBERCULOSIS AFTER ALPINE TREATMENT 499

128. SKIAGRAMS IN TUBERCULOSIS 500

By kindness of Dr. H. W. O. Frew, Senior Tuberculosis Officer, County of Renfrew.

129. THORACOPLASTY SCAR 502

130. COTTAGE GARDEN AT PAPWORTH VILLAGE SETTLEMENT 503

131. MASS MINIATURE RADIOGRAPHY OUTFIT 505

By Courtesy of Messrs. Watson & Sons (Electro-Medical) Ltd., London.

132. SCHEME OF TUBERCULOSIS CONTROL 507

133. TYPHOID FEVER: PATHS OF INFECTION 509

134. MEINICKE TEST 515

By kindness of Dr. W. M. Ford Robertson.

135. 'TRAVELLING' CARD 518

136. HILAR ADENITIS FOLLOWING WHOOPING COUGH 520

By kindness of Dr. James Caldwell, Paisley.

137. FASCIOLA HEPATICA 525

138. SCHISTOSOMA HAEMATOBIUM 526

Partly from P. Manson-Bahr.

139. TAENIAE 527

Partly after Leuckart

140. ECHINOCOCCUS GRANULOSUS 529

After Braun-Seifert and E. Brumpt.

141. LIFE CYCLE OF DIPHYLLOBOTHRIUM LATUM 530

142. TRANSVERSE SECTION OF FEMALE ASCARIS 531

After Graham Kerr.

143. ASCARIS LUMBRICOIDES 532

144. EGGS OF ASCARIS LUMBRICOIDES 533

145. HOOKWORM MOUTHS 533

146. LIFE CYCLE OF A. DUODENALE 534

147. MICROFILARIA OF WUCHERERIA 535

FIG. PAGE

148. FEMALE GUINEA WORM 536
149. NATIVE METHOD OF EXTRACTING GUINEA WORM . . . 537
After Brumpt.
150. TRICHINELLA ENCYSTED 537
151. LEPISMA SACCHARINA 539
This, Nos. 157 to 164, and No. 191 from *Insect Pests in Stored Products* by H. Hayhurst. By kind permission of Messrs. Chapman & Hall Ltd.
152. PEDICULI 540
153. NIT OF P. CAPITIS ON HAIR 542
154. PHTHIRUS PUBIS 542
155. CIMEX LECTULARIUS 543
156. CONORRHINUS MEGISTUS 544
157. EPHESTIA KÜHNIELLA 545
158. PLODIA INTERPUNCTELLA 546
159. LARVA OF PLODIA INTERPUNCTELLA 546
160. LARVA OF TENEBRIO MOLITOR 547
161. TRIBOLIUM CONFUSUM 547
162. CALANDRA GRANARIA 548
163. DERMESTES LARDARIUS 549
164. NIPTUS HOLOLEUCUS 550
165. PHLEBOTOMUS PAPATASII 551
166. LIFE HISTORY STAGES OF MOSQUITO 552
167. MOUTH PARTS OF CULEX 553
168. CULEX PIPIENS 554
169. AËDES AEGYPTI 555
170. SIMULIUM 556
171. LARVA OF SIMULIUM 556
172. PUPA OF SIMULIUM 556
173. MOUTH PARTS OF TABANID 557
174. LARVA OF HOMALOMYIA 558
175. MUSCA DOMESTICA 559
176. LIFE STAGES OF MUSCA 559
177. CALLIPHORA ERYTHROCEPHALA 560
178. LUCILIA SERICATA 560
179. TSETSE FLIES 562
180. LARVA AND PUPA OF GLOSSINA 563
181. LARVA OF FLEA 564
182. FLEAS 565
183. DEVELOPMENT OF B. PESTIS IN RAT FLEA 566
184. MOUTH PARTS OF TICK 567
185. DERMATOCENTOR VENUSTUS 568
186. ORNITHODORUS MOUBATA 568
187. LARVA OF TROMBICULA 569
188. SARCOPTES SCABIEI 569
189. FEMALE SARCOPTES IN BURROW 570
From *Scabies* by Kenneth Mellanby. By kind permission of Oxford University Press.
190. SCABIES 571
191. ALEUROBIUS FARINAE 572

FIG.

192. BLACK RAT
193. BROWN RAT
194. HEALTH LEAFLET BY "FOUGASSE"
By kind permission of the Artist.
195. HEALTH LEAFLETS
By Courtesy of the Scottish Council for Health Education.
196. HEALTH POSTER
By Courtesy of the Central Council for Health Education.
197. HEALTH EXHIBITION POSTER
198. HEALTH EXHIBITION POSTER
199. KEW PATTERN BAROMETER
200. BAROMETER AS READ 985.0 mb.
201. BAROMETER AS READ 1012.7 mb.
202. CISTERN OF FORTIN BAROMETER
203. WORLD PRESSURE
204. CUP ANEMOMETER
205. PLANETARY WINDS
206. CYCLONIC SYSTEM
207. LINE SQUALL
208. MEAN ANNUAL RAINFALL, BRITISH ISLES
209. RAT FUMIGATION ON BOARD SHIP
From *Preventive Medicine* by Hutt and Thomson. By kind permission of Messrs. Methuen & Co., Ltd., London.
210. FAMILY CONSULTATION, HEALTH CENTRE
By kind permission of the authors of *The Peckham Experiment.*
211. CROOKSTON COTTAGE HOMES
This and No. 212 by Courtesy of the Corporation of Glasgow.
212. CROOKSTON COTTAGE HOMES

LIST OF PLATES

PLATE

I. AMANITA PHALLOIDES
This and Plate II. from *Poisonous Fungi* by John Ramsbottom. By kindness of Messrs. Penguin Books Limited, London.

II. AMANITA MUSCARIA

III. POISONOUS PLANTS OF BRITAIN
This and Plate IV. from Glaister's *Medical Jurisprudence.* By kindness of Messrs. E. & S. Livingstone.

IV. POISONOUS PLANTS OF BRITAIN

LIST OF TABLES

TABLE PAGE

1. MATERNAL MORTALITY RATES 24
2. CENTRAL DEPARTMENTS 119
3. BIRTH, DEATH AND INFANT MORTALITY RATES 156
4. STANDARD MILLION 159
5. DEATH RATE STANDARDISATION: DIRECT METHOD . . . 160
6. DEATH RATE STANDARDISATION: INDIRECT METHOD . . 162
7. OCCUPATIONAL MORTALITY: MALES 163
8. OCCUPATIONAL MORTALITY: WIVES 165
9. OCCUPATIONAL MORTALITY: SINGLE WOMEN 167
10. LIFE TABLE 169
11. ORDER OF PROCEDURE FOR LIFE TABLE 171
12. DEATH RATES, SCOTLAND 174
13. DEATH RATES, SCOTLAND: CALCULATION OF CONSTANTS . . 177
14. RELATIVE VARIABILITIES 178
15. GROUPED FREQUENCY DISTRIBUTION 180
16. GROUPED FREQUENCY DISTRIBUTION: CALCULATION OF CONSTANTS 182
17. CUMULATIVE FREQUENCY 188
18. DEATH RATES, PULMONARY TUBERCULOSIS AND ENTERIC FEVER 197
19. SMOOTHING: MOVING AVERAGES 200
20. SMOOTHING: LEAST SQUARES 201
21. TWO-FOLD CORRELATION 203
22. REGRESSION: ARRAYS OF FREQUENCIES 206
23. REGRESSION: FITTING OF REGRESSION LINE 206
24. PROPHYLAXIS OF CORYZA BY VACCINE: CHI-SQUARE TEST . . 209
25. ESTIMATED DAILY REQUIREMENTS OF NUTRIENTS PER HEAD . 225
26. PERCENTAGE COMPOSITION OF MILKS 230
27. DESIGNATED MILKS: ENGLAND AND WALES 240
28. DESIGNATED MILKS: SCOTLAND 241
29. CHEMICAL PRESERVATIVES 276
30. PROHIBITED COLOURS 277
31. WORKING CAPACITY 292
32. CUBIC FEET OF SPACE PER HEAD 294
33. CHEMICAL WATER STANDARDS 330

TABLE

34. SUNDRY WATER ANALYSES
35. QUALITATIVE WATER ANALYSIS
36. ISOLATION PERIODS
37. QUARANTINE PERIODS
38. DIFFERENTIATION OF TAENIAE
39. INSECTA: ORDERS OF MEDICAL INTEREST
40. DIPTERA: GENERA OF MEDICAL INTEREST
41. TOXICITY OF VARIOUS INSECTICIDES TO LARVAE OF AËDES AEGYPTI
42. HEALTH EDUCATIONAL ORGANISATIONS
43. SCHEME FOR PUBLIC EDUCATION IN HEALTH
44. WORLD PRESSURE REGIONS
45. BEAUFORT SCALE
46. WORLD CLIMATES

I.

GENERAL SURVEY

Hygiene has been defined as the science of health. It is also the art of health and, as such, seeks its end by fostering ways of healthy living. In Greek story the patroness of hygiene was Hygeia, the goddess of health. Her father was Asclepius, the legendary founder of medicine. Her grandfather was Apollo, the sun-god of the silver bow, who had power over pestilence, to loose it upon men but also to restrain it. Hygiene thus in these far-off days had very distinguished family connections, and during the glory of old Greece its aims were correspondingly high, its finished product being the athlete, perfect in beauty, strength and performance, the hope of his native city-state in the Pan-Hellenic Olympic games.

Down the Centuries

Hygiene, when the world was young, was what we now call personal hygiene. It concerned itself with simple practices in the choice of the individual. It drew people's attention, for example, to the right uses of air and water and discretion in diet. The Greek physician Hippocrates recommended sleeping in the open air, advised warm baths and, though he knew of many drugs, often preferred to treat his patients on dietetic lines. In Alexandria a century later Erasistratus, another Greek, had good to say of dietetics and vapour baths. Three more centuries on in imperial Rome, Celsus when compiling his work on medicine devoted four of its eight books to the treatment of disease by diet and regimen. About this time watering places were much frequented by wealthy Romans, and the provision in Rome itself of spacious public baths, the ruins of which are still imposing, encouraged the outward use of water by all classes.

Later, but before the Western Empire fell, the practice of bathing in Rome had gone out of favour. In the view of the Christian Church, now rising to power, the body of man in this fleeting world was base, if not essentially evil. To cleanse it therefore, as by washing, was either a futile task or a presumptuous sin. A degree of personal uncleanliness came to be accounted praiseworthy, and hermits who notoriously excelled were reverenced as holy men. This strange idea took deep root, and maintained its hold on Europe through the Middle Ages. It stands however to the credit of a hygienically unprogressive period that the medical school of Salerno had a good system of dietetics, one of the maxims of which recommended 'joy and temperance and repose' to hold sickness at bay when doctors failed.

Coming now to modern times, we can discern a turning back to the old Greek simplicity, slow indeed in its early stages, but more rapid at the close. A pioneer in this, as in another great movement, was John Wesley. He advocated the open-air life together with plain feeding. Tobias Smollett, too, was in his way another pioneer. He published 'An Essay on the External Use of Water.' In the closing years of the eighteenth century James Currie was employing affusions of cold sea water to control pyrexia. During the nineteenth century medical baths of various kinds and temperatures were increasingly used for the sick. Then people in good health also took to bathing. They found it invigorating, pleasant, and conducive to self-respect. A complete bath at least once a day became good form in Britain. The Law too declared for bathing, prescribing that baths must be installed in subsidised houses. Public and school swimming baths are now widely available, and at coast resorts, where health and pleasure join, spacious facilities are offered for sea bathing. These are right uses of water.

As regards the right use of air in the communal life of today we see it in operation in many ways: in the devices for bringing the fresh air into our houses, hospitals, halls, factories and mines, in our open-air schools for children, in our public parks, our field sports, and our walking tours, and in our scantier clothing than our grand-sires wore, which admits the vitalising air more freely to the body surfaces. As regards discretion in diet, the last of the three hygienic virtues cited above from days of old, it may be claimed that the progress of science in the field of nutrition enabled the people of our country, throughout the Second World War, to enjoy food selected with a more enlightened discretion than ever in the past. So hygiene in one shape or another has been handed down the centuries.

Preventive Idea

In the mediæval hygiene which sought to hold disease at bay we can trace the beginnings of the preventive idea. It comes out too in early laws on the subject. A statute of Richard II in 1388 forbade any person to put or cast garbage in places within or about cities, since such practices make the air corrupt and infect, 'and many maladies and other intolerable diseases do daily happen.'

But the strongest preventive impulse dated from still earlier times. Through the ages great pestilences had come at recurring intervals to spread panic among the nations. On the occasion of such an outbreak desperate measures would be applied in the hope of staying its progress, but in the general ignorance of the mechanism of infection the methods adopted, though often vigorous, were equally often unproductive. There is, for example, no indication that when in 1348 the Black Death menaced France the King's threat to mutilate blasphemers did anything tangible towards averting the ravages of the plague. Even well into modern times, though English medicine had made great advances in other directions, the precise way in which infection worked still remained obscure. Vaccination against smallpox, first carried out by Edward Jenner in 1796, was an isolated point of light in the general darkness and the measures by which this country finally countered, as it did, the great outbreaks of fever during half of the nineteenth century were in the main not prompted by any precise aetiology but were general sanitary improvements looking back in principle to 1388.

True understanding of the infective process came from about 1870 onwards as a result of Pasteur's work in confirmation of the germ theory. He showed how infectious diseases were conveyed by living germs and how they could be prevented by methods directed against these organisms or their noxious products. On the knowledge which has broadened out from these discoveries there has been developed the present-day system of prophylaxis of the infections.

Prevention in hygiene is not however limited to the specific fevers. Given knowledge of the causation of any disease its prevention can be attempted, and, given precise and adequate knowledge, attempted usually with success. The industrial diseases have the common feature of being caused by industrial processes, and the organisation of preventive measures at factories where such processes are carried on has proved effective for their control. Other examples of organised prevention are, in the field of obstetrics, prenatal clinics for the prevention of the complications of pregnancy and labour, and in the field of school hygiene milk-in-schools schemes, with a view to prevention among the children of the conditions which arise from the deprivation or too sparing use of certain food components.

The preventive idea has been extended also to cover early treatment, overtaking disease before it gets a firm hold and so preventing serious damage. We saw the principle in the National Health Insurance scheme which offered the insured person every inducement—or at least no deterrent—to consult his medical adviser early with regard to ailments which may seem trivial to himself. We see it too in the proposal, not yet in general operation, that doctors should examine their patients, sick or well, periodically with the object, among others, of bringing under medical or surgical care the unsuspected beginnings of grave disease. The psychopathic clinics attached to some general hospitals furnish another example of the endeavour to take action on the early signs of deviation from the normal.

Furthermore the preventive idea includes the cure of chronic conditions for the purpose of preventing disabilities to which they may give rise if allowed to persist. The enlarged glands, otorrhoeas, carious teeth and circulatory disorders, lately rife and still occurring among British school children, even when not severe enough in themselves to attract much notice, are liable if left untreated to result in established defect or bacterial invasion. The organisation of the medical inspection and treatment of school children, which led to the cure of many of these chronic conditions, inasmuch as it also forestalled their subsequent complications, has had both a curative and a preventive value.

While prevention and treatment are logically opposites, prevention seeking to prevent disease from beginning and treatment to cure it once it has begun, yet in hygiene, as shown above, the two seem to meet together and even to mingle. They are not however to be confused. It is a question of the point of view. Looking to the present the cure is good in itself: looking to the future it possesses an implied preventive significance since it may serve to avert a train of ills.

Humanism

The law-making which accompanies the practice of hygiene represents a collective effort to safeguard the community against insanitary procedure by its component individuals. In England up to the seventeenth century the measures adopted for this purpose, apart from an occasional excursion into quarantine or water supply, mainly amounted to prohibiting nuisances of various kinds. In the eighteenth century the rise of the humanistic or humanitarian movement, sponsored by Wesley, Howard and other high-minded men, inspired new ideals and fresh vigour. Humanism, by fixing attention on the essential unity of the social fabric, created a more lively sense of public responsibility and evoked a new chivalry to protect the weak. One of its first fruits was the Health and Morals of Apprentices Act, 1802, which provided for pauper children bound apprentices to masters that they should not have to work more than twelve hours a day, that they should not have to sleep more than two in a bed, and that they should be taken to church at least once a month. These provisions mark the beginnings of industrial hygiene. At the same time the links between sickness and poverty were recognised, so that the question of the sick poor came into prominence. The Act of 1835 for the Regulation of Municipal Corporations opened out new prospects of effective local government. Demands were made for reforms in which Southwood Smith, Edwin Chadwick, the seventh Earl of Shaftesbury and Sir John Simon played their valued parts. So it came that communal effort received a philanthropic bias and hygiene was guided in the direction of social service.

Further Progress

Pasteur's work was the starting point of further progress. Pioneers before his time had prepared the way. In this country William Harvey, Thomas Sydenham, John Hunter and Edward Jenner had each contributed memorably to the stock of medical knowledge. But what followed Pasteur's researches was unexampled. Disease after disease was made to disclose its *contagium vivum* and antidote, and the new sciences of bacteriology, immunology and medical protozoology created means to control infection never before thought possible. Keeping touch with these advances there took place a quickening of interest in nutrition and other medical fields. These activities, which were not weakened but rather intensified by the First World War declared in 1914, in the end added signally to the resources of hygiene. On the ethical side the sense of public duty has deepened and widened since its first enlargement under the stimulus of humanism. The social services now cover prenatal life, maternity, infancy, pre-school life, the school child, the working life and old age. They care for the destitute, the sick, the halt, the blind and the mentally defective. Examples of their operation have been cited above. Gaps still exist in schemes, and it is regrettable that services are not always adequately used by those for whom they are provided, but speaking generally it may be said that in these Islands the preventive benefits of hygiene have been extended to the community with a generous hand.

Hygiene Today

Yet prevention alone is not enough. In 1917 during the final muster of the First World War to meet the expected enemy advance in the following year it was revealed that, of the still unenlisted men of Britain, one-third were unfit to serve: the army could not use them. In the emergency of the time the lesson was driven home that the efficiency of the people must be the final criterion of the value of a hygienic system. A preventive policy will preserve health: it is a good and necessary thing: but, without some end beyond, it becomes a negative inspiration of little force. An efficiency policy, on the other hand, when strengthening prevention, has a constructive power. Efficiency can be got by training and tested by performance as in the far-off days of Greece. In the hygiene of today, which aims at efficiency, the wheel has come full circle after more than twenty centuries, but with a difference. The hygiene which produced the Greek athlete was a fine specialism: the benefits of the new hygiene are, in the broad humanism of our time, the heritage of all. The purpose now is to bring out the best in each according to his powers, ranging from those whose vocations demand high talents, fortitude or skill down to the mental defective in an institution who is learning to sweep a room. Hopes too for the ultimate betterment of the general racial stock may perhaps in time to come be realised in some moderate way through the cautious application of the principles of genetics.

Prior to the Second World War visible progress had been made. Children, under child welfare schemes, were fostered in infancy, though less adequately cared for at pre-school ages. School children had physical training and received education in hygiene. For adolescents there was no single inclusive scheme, but many on their own initiative developed their powers by means of competitive sports and games, or else, with such useful aids as youth hostels and summer camps, took health-promoting pleasure in the open-air life.

Under the stimulus of the Second World War interest in child nurture was intensified. Young children had priority in the rationing of essential foods. Owing to movements of the population the supervision of school children was disturbed locally, but school meals were widely extended. For adolescents there was still no universal plan, but many boys and girls found fresh outlets for their pent-up energies in military or civilian training.

Public Health

While personal hygiene is the care of his personal health by the individual, Public Health, or Community Hygiene, is the care of community health by the community as a whole. It may be sub-divided into many branches, for example, school hygiene, industrial hygiene and mental hygiene. Social Hygiene usually means hygiene applied to social amelioration or reform, though the expression is often restricted to the control of venereal disease. When public health is on a national basis it is sometimes termed State Medicine. Sanitary Science means environmental hygiene in relation to water supplies, sewerage, nuisance and other matters. Preventive Medicine is a useful expression somewhat variously employed. It includes at least the preventive aspects of hygiene as already described.

Personal Hygiene in the case of the individual and Public Health in the case of the community, as the terms are commonly used, taken together cover the field.

The administration of Public Health is now organised in Britain with some completeness. The principal central authority in England and Wales is the Ministry of Health under the Minister. The local authorities are County and Borough Councils and the Councils of County Districts. In Scotland the central health authority is the Department of Health for Scotland under the Secretary of State for Scotland, and the local authorities are County and Burgh Councils.

The principal public health officer of a local authority is the Medical Officer of Health. Other public health officials are the Sanitary Inspector, the Meat Inspector, Health Visitors and specialists in various branches.

Voluntary effort has throughout played a notable part in the development of public health in Britain. Voluntary associations, under various names and in various places and on either a local or a national footing, are rendering valued co-operation or aid to the official health authorities. The distinguished record of the great voluntary hospitals is known to all, and it should be added that civil hygiene owed much in its development to naval and military hygiene and may still profit by the example of the Services, the Air Force included. Especially under the impulse of the Second World War signal advances in preventive and remedial medical science were achieved by Service personnel under the distinguished auspices of the Medical Research Council.

II.

INHERITANCE

The science of genetics takes to do with the principles and mechanism of inheritance, which in the human species is biparental, part coming from the father and part from the mother.

Genes

The agents or factors of inheritance are the entities known as genes. They exist in the resting nuclei of germinal and somatic cells and in the chromosomes of cell division. In man the chromosomes occur in pairs, this arrangement being termed 'diploid.' Both constituents of a pair are made up of segmental subdivisions called chromomeres. These chromomeres contain the genes. They are paired also. Recent work by Painter on the giant chromosomes of the salivary gland has enabled a technique for the location of genes to be developed. Normally one of the paired chromosomes carries the complete set of paternal genes and the other all the maternal genes, though sometimes partial crossing over occurs. When a sperm fertilises an ovum, transforming it into a zygote, the paternal and maternal genes pair according to function.

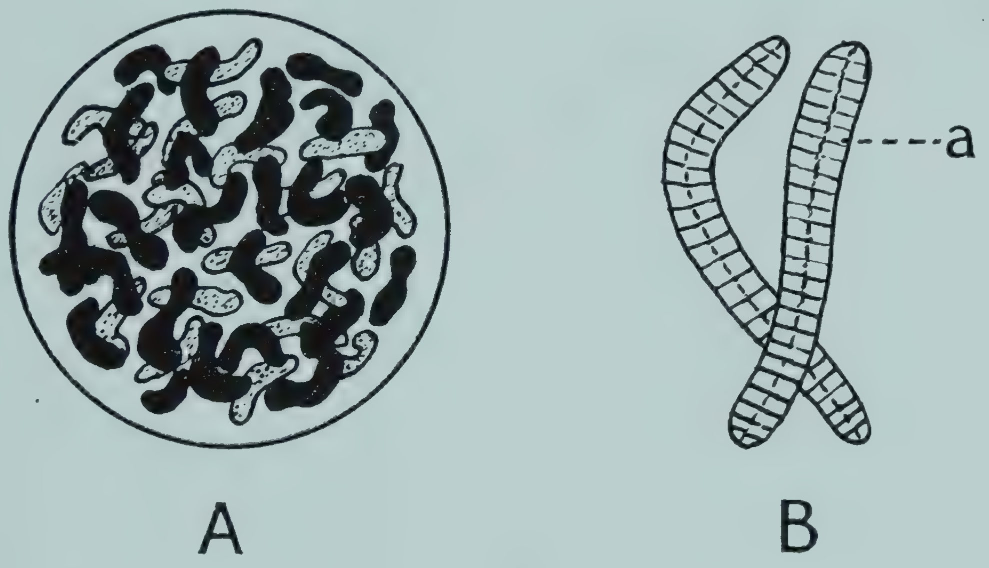


Fig. 1.—Chromosomes.

A Chromosomes in neucleus of human cell.
B Individual chromosomes, showing chromomeres (a).

Genes for the same function may differ in their potency. When two unequal genes meet in a pair the stronger prevails and is said to be 'dominant,' while the weaker becomes 'recessive.' Alternatively according to some, the dominant gene exists alone, side by side with a blank file. As a rule the functioning of a dominant gene produces a normal or advantageous character, and that of a recessive gene abnormality or damage. Thus pigmentation, which is normal, is dominant to albinism. There are however injurious dominants such as brachydactyly, and there are advantageous recessives, such as blue eyes, which though recessive to brown are admired by many.

In some forms of mental deficiency, which are recessive, the dominant gene functions for both itself and its weak companion and induces normal mental development. This is good for the individual, but the recessive gene is preserved in the line of inheritance and, if opportunity offers in some future mating, may give rise to a case of mental deficiency. In some instances, for example in relation to skin colouring, the domination of the stronger gene is incomplete. Hence blending or intermediate inheritance, as in mulattos, who are neither pure white nor pure black.

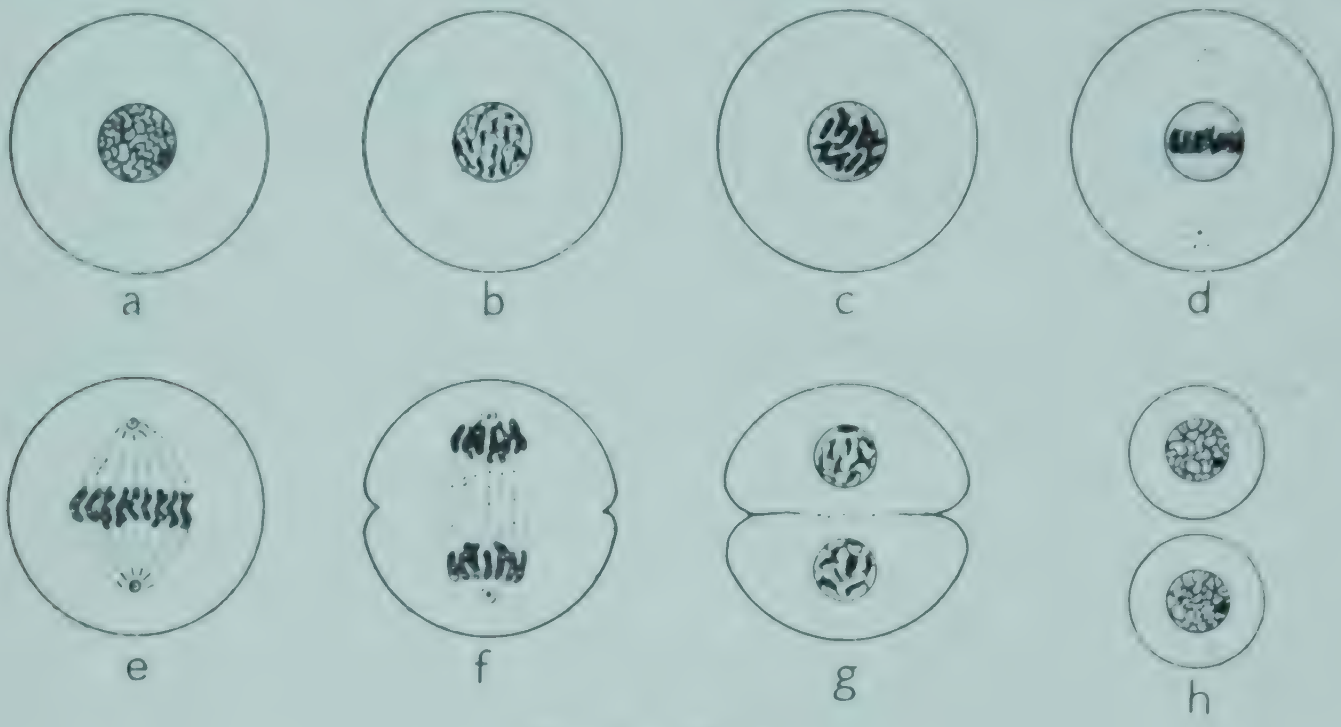


Fig. 2.—Mitosis.

- a Resting nucleus.
- b Fractionation of Chromatin.
- c Separation of individual chromosomes.
- d Equatorial disposition of chromosomes in pairs: appearance of attraction spheres.
- e Diploid chromosomes about to separate.
- f Separation of chromosomes: remnant of spindle: commencing division of cell protoplasm.
- g Formation of membrane round daughter nuclei: further division of cell protoplasm.
- h Completion of daughter cells.

A person in whom both genes of a pair are either dominant (DD) or recessive (rr) is said to be homozygous or a homozygote with respect to the heritable character. A person in whom one gene of the pair is dominant and the other recessive (represented by Dr) is said to be heterozygous or a heterozygote.

Chromosomes

The tissue cells of the human body contain 24 diploid chromosomes, being 48 chromosomes in all to each cell. It is so in the original zygote. When the zygote proceeds to divide, its nucleus enters into mitosis (Fig. 2). Each diploid chromosome duplicates itself into 2 new diploid chromosomes one of which moves to one pole of the dividing zygote and the other to the other. Finally 2 new cells take form, each, like the original zygote, containing 24 diploid chromosomes. And in every subsequent cell-division by which the body is at last built up the pattern is preserved.

In the divisions of the germinal cells, located in the testes or ovary, which lead up to the liberation of free sperms or ova to take their part in founding the next generation, there is a stage of meiosis, or reduction division. This is preceded by a segmental interchange between the diploid chromosomes so that paternal genes pass over to the maternal and *vice versa*. Meiosis differs from mitosis in that the homologous chromosomes, instead of duplicating themselves, separate into their paternal and maternal constituents, and different members of each pair pass into each daughter cell. In the end there emerge from the divisions of a male germinal cell 4 sperms each containing 24 single chromosomes, or half the type number for the species, representing the various combinations of paternal and maternal qualities in a frequency determined by the laws of chance. From the divisions of a female germinal cell there results 1 ovum similarly constituted. Thus every sperm or ovum contains one-half the number of chromosomes present in the tissue cells of its producer.

The chromosomes of man are of two varieties, the sex chromosomes and the autosomes. The sex chromosomes are the vehicle of (1) sex-linked inheritance, while the autosomes display the pattern of (2) autosome inheritance.

Sex-Linked Inheritance

The two sex chromosomes are lettered respectively X and Y. In man the X chromosome is large and well developed. Y is of small size. Two X chromosomes are present in the somatic and germinal cells of women, but an X and a Y chromosome in those of men. It follows that the ova of women are of one kind: they must all contain an X chromosome. It follows also that the sperms of men are of two kinds, some containing an X chromosome and some a Y. If a sperm containing an X chromosome conjugates with an ovum containing, as it must, an X chromosome the XX zygote produced will develop into a female. If a sperm containing a Y chromosome conjugates with an ovum containing an X chromosome the resulting XY zygote will develop into a male. The presence of the Y chromosome confers masculinity. Just over fifty per cent. of the fertilisations of human ova are by Y sperms, the ensuing slight preponderance of male over female births being due, it is believed, to the superior infiltration power of the Y chromosome. It appears also that this chromosome carries few genes. Hence sex-linked inheritance through Y is uncommon in man. The X chromosome of the male parent always passes to his daughters. It cannot pass to his sons. The X chromosomes of the female parent pass to both her sons and daughters.

In the case of a heritable character carried by a gene located in the X chromosome of a male parent, since his X chromosome always passes to his daughters, the heritable character if dominant will be manifest in them, if recessive will be blanketed by the companion gene of the other X chromosome and will not show. Since the X chromosome of the male parent never passes to his sons the character whether dominant or recessive will not be manifest in them.

If the heritable character is related to the X chromosome of a female parent, since her X chromosomes pass to her daughters, it will if dominant be manifest in them but if recessive will not. Since her X chromosomes pass also to her sons the character whether dominant or recessive will be manifest in them, the manifestation of the recessive character being due to the fact that the X chromosome in the male cell is companioned by an inert Y chromosome which does not provide a normal gene to blanket the recessive.

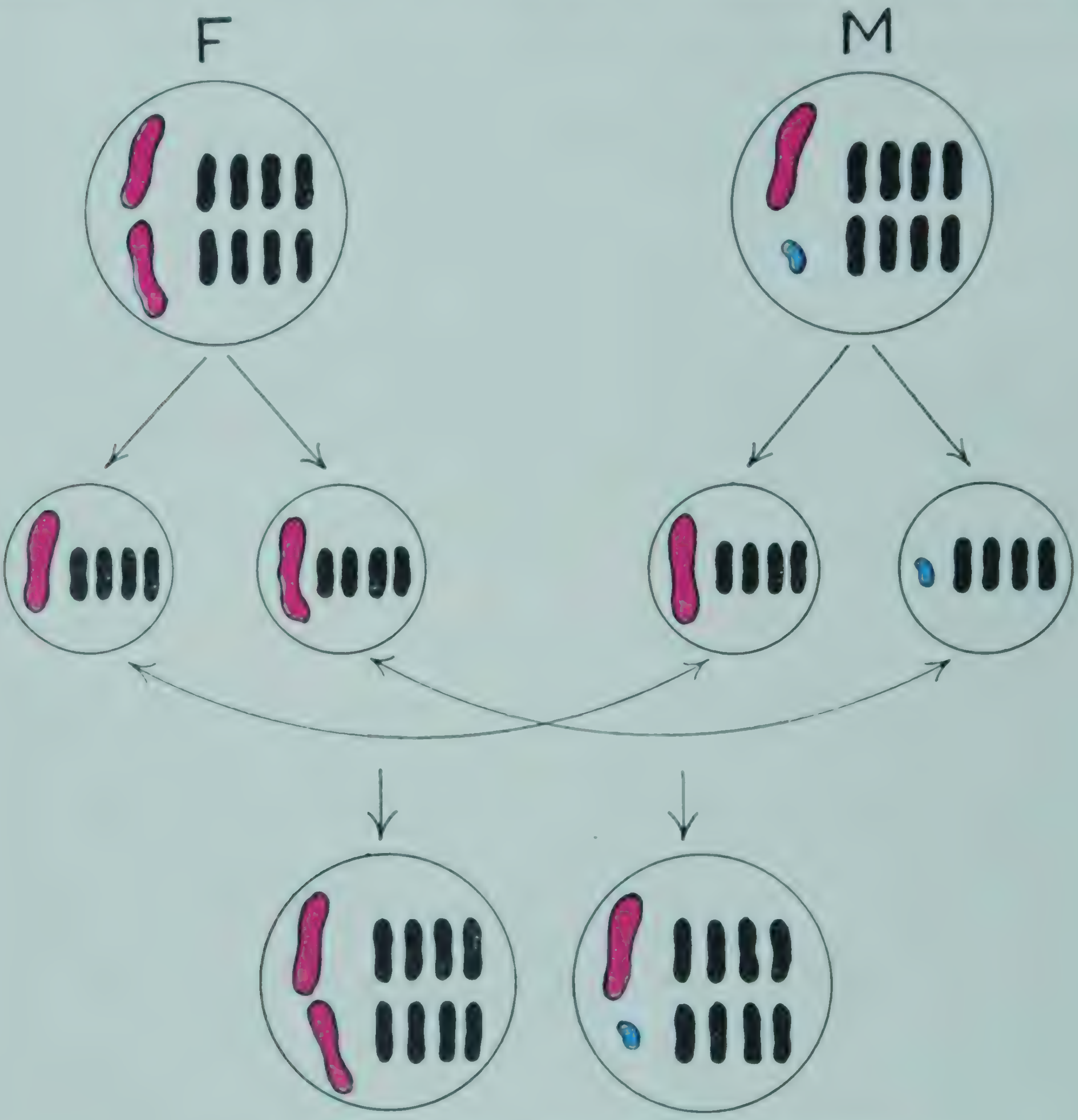


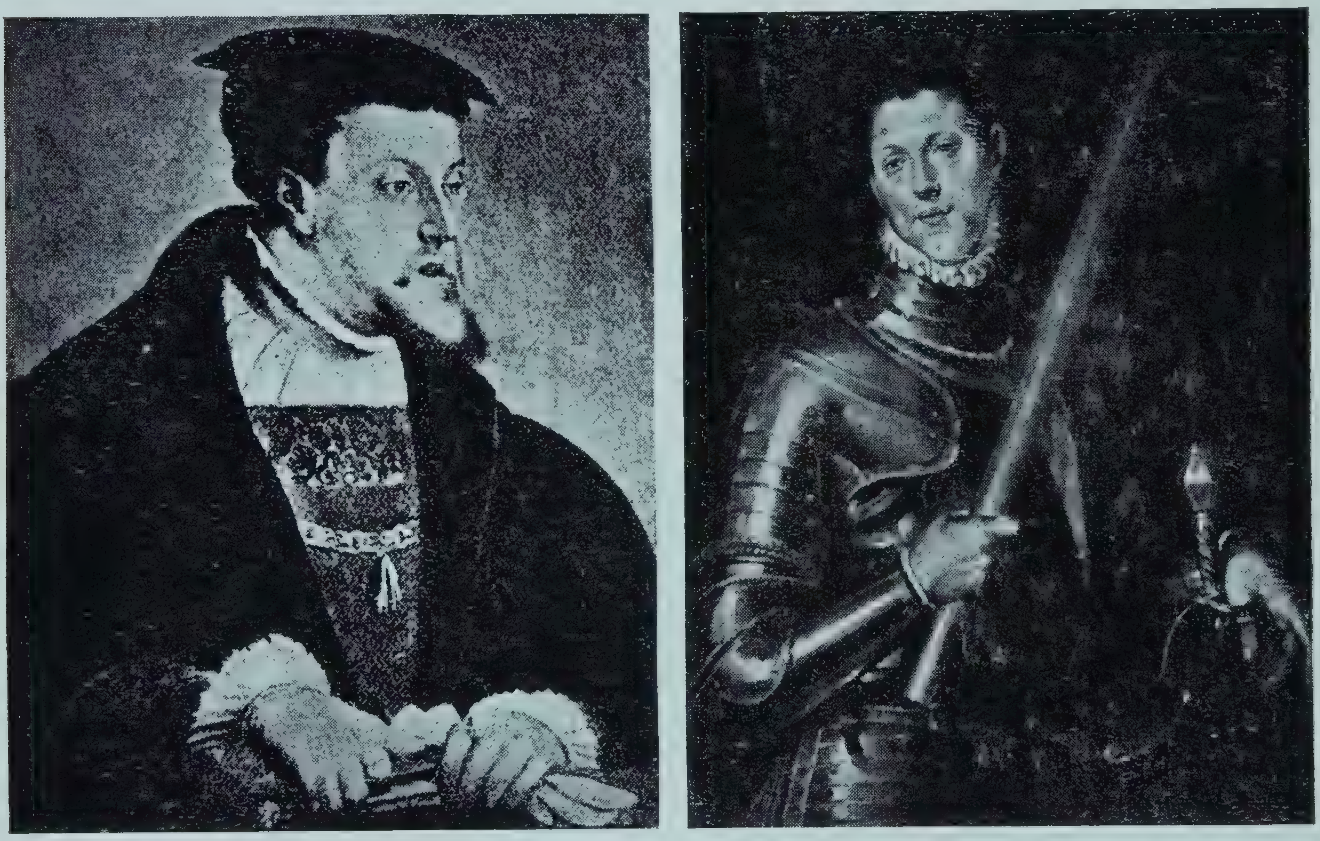
Fig. 3.—Chromosomes Sex-linked inheritance.
X Red. Y Blue.

Dominant sex-linked inheritance has not yet been recognised in man. Recessive sex-linked inheritance, which is not uncommon, occurs with haemophilia, muscular atrophy, nyctalopia, optic atrophy and red-green colour blindness. For example, in haemophilia, if a heterozygous female marries a normal male, half her sons will be bleeders. Her daughters will be apparently normal but half of them will be heterozygotes and capable when they marry of transmitting the disease condition to half their sons. A female bleeder can only occur if a male bleeder mates with a female bleeder or with a female heterozygote.

Evidence recently brought forward by Haldane suggests that the segmental interchange between the diploid chromosomes which precedes meiosis may also occur between the X and Y chromosomes, leading to a partially sex-linked inheritance of certain characters. Haldane has cited spastic paraplegia, complete colour blindness, retinitis pigmentosa, both dominant and recessive, Oguchi's nyctalopia and xeroderma pigmentosum, which last is a cutaneous light-sensitivity, as examples of the partially sex-linked effect. He regards it as a striking and possibly significant fact that so many of his examples are concerned with light-sensitivity.

Autosome Inheritance

All chromosomes other than X and Y are called autosomes. While X and Y, though companionate, differ morphologically, every pair of autosomes is composed of two similar members. While the Y chromosome of a father can pass only to his sons and his X chromosome only to his daughters, his autosomes, as well as the autosomes of the female parent, pass to both sons and daughters, and are thus not sex significant.



The Emperor Charles V. His son, Don John of Austria.

Fig. 4.—The Hapsburg Lip.

Among the characters recorded as dominant in autosome inheritance are dark hair, brown eye colour, the Hapsburg lip (Fig. 4), achondroplasia, brachy-, syn- and poly-dactyly, hypotrichosis, diabetes insipidus, Huntington's chorea, retinitis pigmentosa, von Recklinghausen's disease, coloboma iridis, displaced lens, progressive muscular atrophy and angioneurotic oedema. Since the character is dominant it will be manifest in both homozygotes and heterozygotes. The affected persons are however usually heterozygotes. Half the children of an affected parent are likely to be affected.

Among the recessive characters are light coloured or red hair, blue eyes, albinism, juvenile amaurotic idiocy, Friedrich's ataxia, Menière's disease, microcephaly, deaf-mutism and osteosclerosis. Since the character is recessive it will be manifest in homozygotes only, not in heterozygotes, and hence may reappear in families after missing a generation or two.

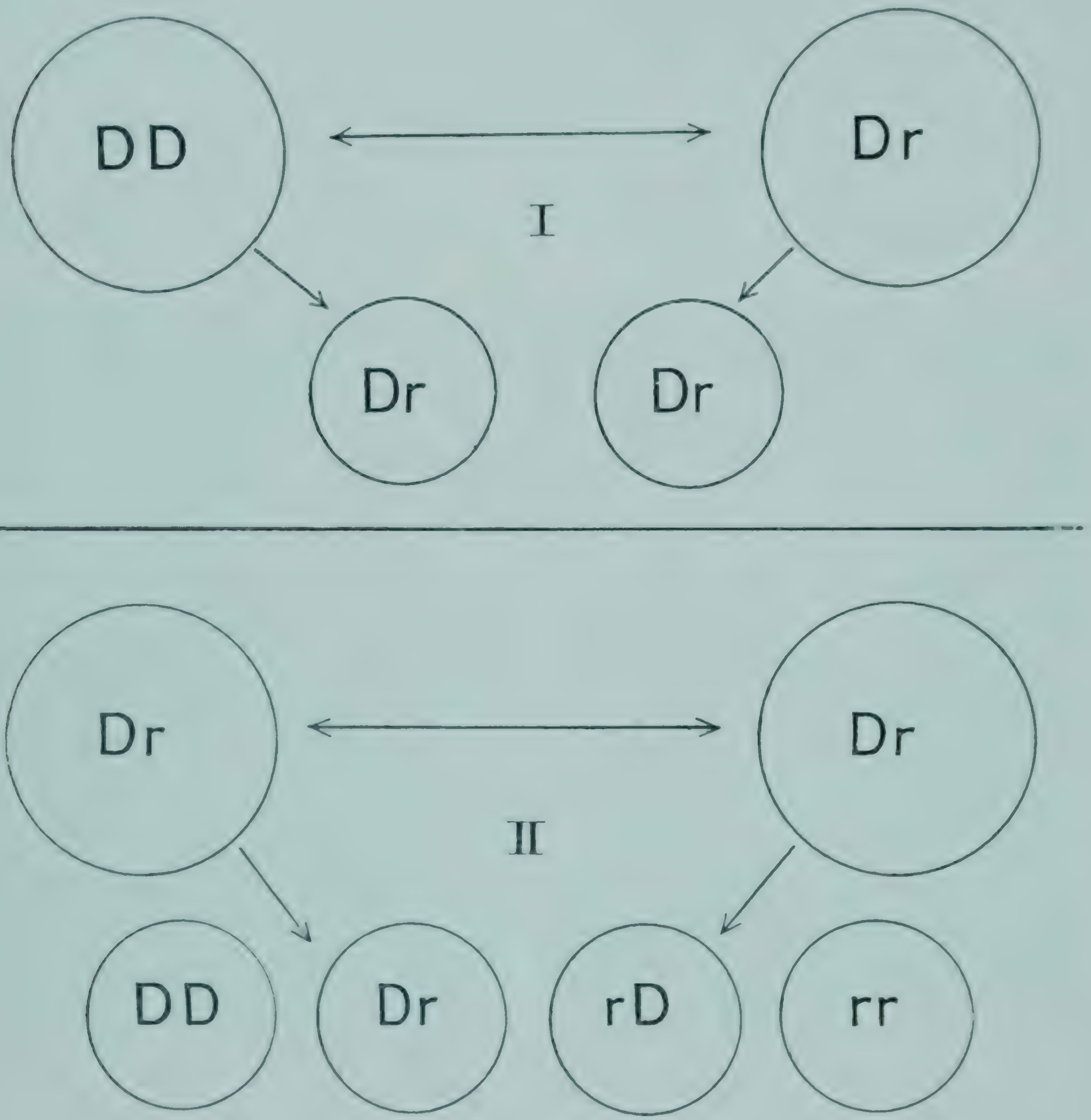


Fig. 5.—Mendelian Ratio.

Mendelian Ratio

Gregor Mendel, the Moravian abbot who experimented with pea plants in the middle decades of the nineteenth century, was the first to recognise the existence of dominant and recessive 'elements' as he then called them, and also the first to trace the secret pathways of the recessive. His work was re-examined and verified in 1900 by de Vries in Holland and by von Tschermak in Austria, working independently, and the foundations of modern genetics then laid. Using his pea plants Mendel observed that when he crossed a pure dominant with a pure recessive the recessive character disappeared in the next generation, but reappeared in the next again in the proportion of 3 dominants to 1 recessive. This proportion of 3 to 1 in autosomal inheritance is known as the Mendelian ratio. It is used as a test for the simple recessive in human genetic studies, though it may not be demonstrable in multifactor inheritance.

In modern terminology, if we cross homozygous DD with homozygous rr we find the next generation to be all heterozygous Drs. If we now mate the heterozygous Drs, we get in the next generation again DD, Dr, rD and rr. DD is a homozygous dominant, Dr and rD are heterozygous dominants. In these 3 the dominant character is manifest, while rr shows recessive, so giving the Mendelian ratio of 3 to 1 (Fig. 5).

The concept of dominants and recessives and the Mendelian ratio, though first worked out with peas, apply also to other plants and to animals, including man. The individuality of the blood is a Mendelian inheritance, and blood grouping tests have on this account figured in cases of disputed paternity.

Mutation

Gene mutation is due to intrinsic and permanent change in the gene substance. It has been produced experimentally in the fruit fly, *Drosophila melanogaster*, by exposing the insect during the maturation of its germinal cells to radium or X-rays or the action of CO_2 or extremes of temperature. If one or both of a pair of genes in the germinal cells of the fly have been damaged in the process, its offspring will exhibit a corresponding new character and hand it down through subsequent generations. Similar mutations have been effected in the case of the common laboratory animals, and in many plants, and have been observed to occur in them as if self-originated. Among examples of gene mutation in domestic animals may be cited the ancon sheep and the polled cattle of Hereford. For such apparently spontaneous mutations the cosmic rays have been held accountable. It is believed that man also is subject to these changes. Cases of haemophilia emerging in families free of the ancestral taint have been ascribed to gene mutation.

The forces above noted act by way of damaging the genes so that the mutations which they produce are usually deleterious. We cannot by any method bring about advantageous mutations, either by strengthening weak genes or improving the normal. Still less can we cause new genes to come into existence, either strong or weak.

Lethal Factors

The existence of lethal genes has long been recognised by both plant and animal geneticists and there is now evidence of their occurrence in man. The lethal factor may be gametic, leading to the destruction of the germ cell, or zygotic, in which case the fertilised ovum dies or fails to develop normally. A classical example of the lethal effect in genetics is furnished by the breeding of yellow-coated mice in which yellow is dominant to grey. When yellow is crossed with yellow the offspring are yellow and grey in the proportion of 2 y. to 1 g. and not, as might be expected, 3 y. to 1 g. The inference is that the homozygous yellow mice are unable to survive.

In man it is possible that miscarriages and teratomata are due in some instances to zygotic lethals. Other conditions for which lethal genes have been held responsible include brachydactyly, malignant xeroderma and erythroblastosis foetalis.

Environment

The cytoplasm of the zygote forms the earliest environment of the genes. Later on as the body develops, although the germinal cells are segregated, the genes in them continue, through the body fluids, to make contacts with their corporeal envelope, which is itself responsive to its surroundings in the outer world. There is however no indication that these indirect environmental influences react on the genes in such a manner as to alter the inheritance pattern. Environment on the other hand, though it does not change the gene itself, is capable of affecting the manifestation of a hereditary character induced by it. It should be noted too that seemingly identical defects may be produced by either inheritance or environment. In such cases age and other considerations may have to be taken into account. A defect showing late in life is often, but not always, due to environmental causes.

The impact of environment on the individual may result in his developing new characters, good or bad, which are not of germinal origin. Such acquired characters remain outside the field of inheritance. While aptitudes are transmissible, accomplishments are not. A recent study by Newman of identical twins who had from an early age been reared apart from one another, suggests that physical characters are affected to a greater degree by heredity than are mental capabilities: while mental power depends more upon hereditary influences than does educational achievement. Taking the balanced view, the environmental and hereditary factors are best regarded as inter-dependent and inter-operational, and should be studied together.

Eugenics

Eugenics may be defined as the hygiene of inheritance. It is genetics applied to the improvement of breeds. The term, introduced by Galton in 1883, has come by usage to be limited to human inheritance. The aim is to improve the genetic make up of human stocks. Since we cannot create new desirable genes to order, we proceed by the method of selective breeding, so arranged as to retain the useful genes and eliminate the detrimental.

It is well known that in the vegetable world and in connection with flocks and herds, dogs, horses and other animals selective breeding has been attended with marked and even brilliant results. It was written in a sporting column in 1934 when Windsor Lad won the Derby in record time 'The three great sires of all that is greatest in the English race-horse, Byerly Turk, Darley Arabian and Godolphin, must surely have galloped in ghostly company over Epsom this afternoon and felt pride in their progeny.' But controlled mating, by means of which this and other successes of breeders have been attained, though a good way with animals, is inapplicable to the human subject, with whom other lines of approach have perforce to be attempted. Among such may be cited (1) Individual Action, (2) Organisation and (3) Compulsion, as noted hereunder.

Individual Action. It is in accordance with the principles of eugenics that a person suffering from a heritable defect, or belonging to a family in which such a defect is hereditary, should refrain from marriage. If a heterozygous person with a dominant defect marries a normal person half the children will show the defect. On the other hand if a normal member of the family in which the defect is hereditary marries a normal person the children will be normal. Again if a person with a Mendelian recessive defect marries a normal person the children will be normal, though the defective gene will pass on in the line of inheritance. If however the affected person marries a blood relation the chances are that the defect will show in the children. The same result may ensue upon the marriage of two normal members of a family connection in which a Mendelian recessive is hereditary. With regard to sex-linked inheritance, half the sisters of a male haemophilic are likely to be heterozygotes. If a male haemophilic marries a normal woman half his daughters are likely to be heterozygotes. In neither group is there any distinctive sign to separate the heterozygous from the normal.

It is eugenic that the heterozygous person with the dominant defect should refrain from marriage unless the defect happens to be, say, a minor syndactyly which can be cured by a surgeon. The normal member of the family could marry with an easy mind, but there would be objection on eugenic grounds to the marriage of the Mendelian recessive defective or the haemophilic male or his sisters.

People desiring to marry who are aware of a taint in their family history may consult their doctor as to the course which they should follow. They will doubtless accept the soundness of the advice which he offers them, but it is perhaps not surprising if they tend in most cases to take short views. If the verdict is that their own children will be normal they take a chance with their prospective grandchildren, and being free agents marry accordingly. Any who propose to marry with systematic contraception in view should be dissuaded. The practice is not always reliable and has been described as physiologically unsound. It is condemned by the Church of Rome.

Organisation. Tentative proposals have been made for the organised discouragement of dysgenic unions. It has been suggested that affianced couples should be required to present themselves to the registrar some time before the marriage ceremony. The registrar would then issue to them an official brochure setting forth the risks involved and recommending that a doctor should be consulted before it is too late. This procedure would not only have an educational value but would also increase the numbers of people who sought medical advice. Another suggestion has been that the two contracting parties should, as a condition of marriage, exchange certificates declaring that they believe they are respectively free from certain disease conditions. A person convicted of making a false declaration would be punished by imprisonment, and the Court would be empowered to annul the marriage.

In the North American Union varying degrees of control of marriage are exercised under statute. In some States the law forbids the marriage of feeble-minded persons or of persons suffering from epilepsy or having a criminal or alcoholic history.

Compulsion. If the view came to be widely held that the sum total of heritable defects was undermining the foundations of society, a public demand might arise for a root and branch method which would make it impossible for any defective to attain parental status. All persons showing the defect or defects selected for action would either be sterilised by surgical operation or else permanently segregated in custodial institutions. On this plan, if tolerated, dominant defects would be rooted out in the course of a generation. In the case of Mendelian recessives only the homozygotes could be dealt with, and the inscrutable heterozygotes, against whom with our present knowledge no action can be taken, would continue for centuries to transmit their hereditary defects and produce fresh crops of overt defectives. Further reference to this question is made under Mental Hygiene below.

Of the three lines of approach, that of compulsion, whether involving sterilisation or segregation, is the least commendable. Missing the heterozygotes, who are the chief transmitters, it fails precisely where the need for its aid is greatest. On the other hand, individual action or organisation with a view to restraining the marriage of persons showing a defect or coming of a tainted ancestry, if put into operation on an adequate scale, would tend towards improving the genetic average of the community concerned by preventing the transmission of defects to succeeding generations. Marriages, however, of heterozygotes whose tainted ancestry is unknown to themselves, or known but denied, would not be prevented, while irregular unions would continue all unchecked. Under existing conditions there are limitations to the effectiveness of a policy of marriage control. Nevertheless such a policy embodies the preventive idea.

The science of genetics, which lights the channels along which eugenics may convey its preventive influences, may seem straightforward enough as outlined in this article. The recognition of its manifestations in actual individuals and families is not so easy. In dealing with Man it is not permissible to employ the experimental methods which have been so prolific of data when applied to the lower creation. Even if experiment were authorised the long life and comparative infertility of human beings would bar the way to useful results within a reasonable time. The present-day study of human genetics involves the recording of the phenomena of inheritance as exhibited in contemporary life. Controlled experiment being excluded, human marriages may be regarded as examples of random mating, forecasts from which must for the most part be founded upon mathematical probability. But this method is only significant when applied to large numbers, which seldom occur in a single pedigree. In order therefore to make up numbers of the required magnitude the data of many pedigrees are taken together, and a statistical analysis made of the resulting combined figures. Special importance is now attached to wide-ranging team work, and the evaluation of the pooled findings of many observers. The Eugenic Society, founded in 1906, has greatly stimulated the public interest in race betterment. The general aim

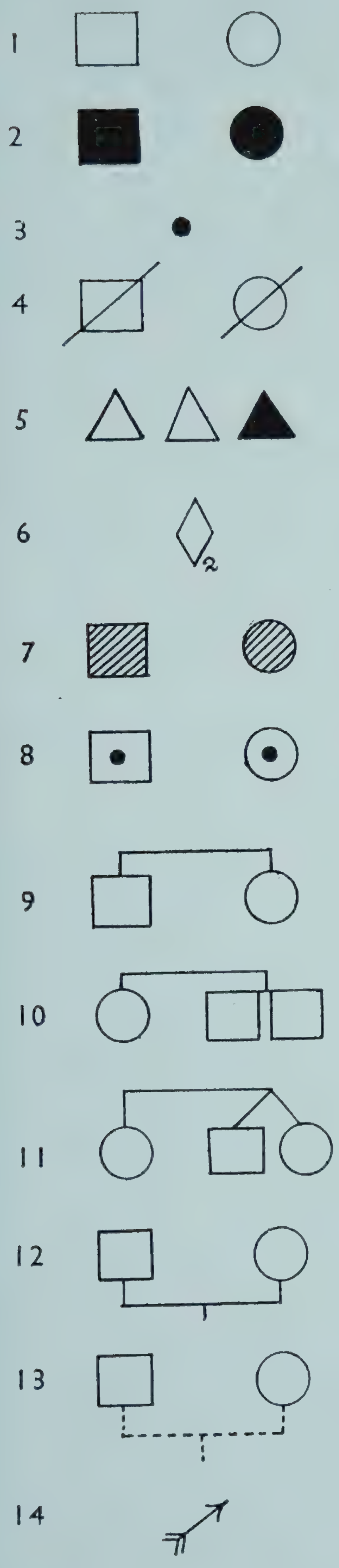


Fig. 6.—Pedigree Symbols.

of the Society is to improve human racial qualities by rational selection and to discourage the propagation of inferior or sub-normal stocks. On the scientific side the Society is concerned with the study of genetics, fertility, race migration and population trends. In the social sphere its work includes investigations of eugenic distribution in the various classes, and surveys of the factors which are deterrent to parenthood in the eugenically sound groups. To facilitate the task of family charting, the Society has devised a 'pedigree schedule' which employs a standard notation (Fig. 6), and by means of reference numbers enables any member of a given family to be located. The completed pedigree with its symbols makes obvious the emergence of ancestral defects, transmission states, consanguineous marriages, still-births and other relevant incidents (Fig. 7). New knowledge of the mechanism of inheritance gained from these and equivalent advances may aid the exponents of eugenics to develop the above-mentioned preventive idea on a more comprehensive basis, and later, when most of the tares have been up-rooted from the field, to envisage constructive plans and the superior racial type whose criteria, C. P. Blacker suggests, should be genetic purity, sound physique, good health, intelligence, love of children and social awareness.

In the meantime we can achieve a good deal for the individual by calling environment in to compensate shortage of the genetic make-up. Appropriate nurture and education can quicken the innate aptitudes, so that a child born ill-equipped may be able to rival one born with better genes but ill-cared for afterwards. Our welfare services play a valued part in helping to raise children of meagre endowments up to, say, average level. But their good acquired qualities, like the humane atmosphere in which they were brought up, remain part of their environment as individuals and are not transmitted to posterity.

1, male (square) and female. 2, showing defect. 3, miscarriage. 4, died in infancy. 5, sex unknown. 6, ancestor (small figure indicates number of ancestors known). 7, possibly defective. 8, carrier of defect. 9, sibling bar (brother and sister). 10, sister and identical male twins. 11, non-identical twins. 12, marriage bar. 13, irregular union (to indicate source of illegitimate progeny). 14, propositus sign (to indicate person about whom a pedigree has been constructed).
(*Modified from C. P. Blacker.*)

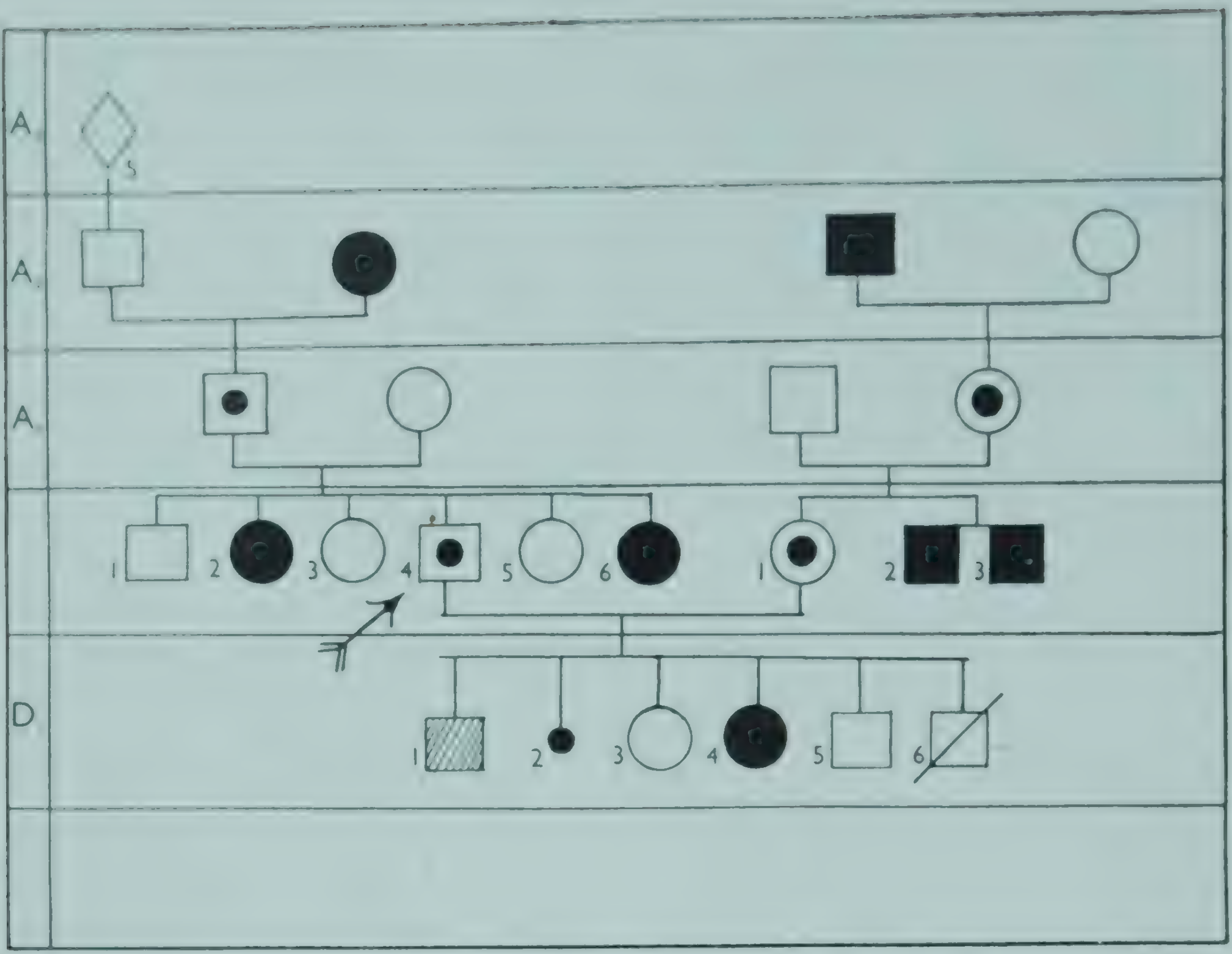


Fig. 7.—Sample Pedigree.

Based on the notation of Fig. 6, the pedigree shows that the Propositus, who is a carrier of the defect, is the fourth child in a family of 6, of whom the second and last are defective. The father of the propositus was a carrier, and his grandmother a defective. No further deficiency is known on the male side, of which 5 ancestors were traced. The propositus married a carrier, whose mother and grandfather were a carrier and a defective respectively. The family of the propositus consists of 5 living children. The eldest is probably defective and the third overtly so. The second pregnancy terminated in a miscarriage and the youngest child, a boy, died in infancy. Generations earlier than that of the propositus are denoted by A_1, A_2, etc., in the left margin; succeeding generations, beginning with the family of the propositus, are marked D_1, etc.

III

MATERNITY AND CHILD WELFARE

THE welfare services in terms of the Public Health Act, 1936, are directed to the care of expectant mothers, nursing mothers and children under 5. Taken together, they constitute a concerted preventive system, acting for the most part by way of the early treatment of deviations from the normal, which if permitted to continue might threaten life or well-being. The services given, according to the manner in which they are organised, are here presented under the two heads of (1) Domestic and (2) Institutional Services.

DOMESTIC SERVICES

Domestic Midwifery. Confinement at home is best conducted in clean, spacious and airy houses which are provided with ample water supply and sanitary equipment. There is however no clear relationship between high puerperal mortality and such conditions as squalor in houses or the small size of houses or even overcrowding. An expectant mother who desires to be confined at home may be assisted by the local authority to procure a maternity outfit and to get a woman to help in the house during her lying-in. She should book in advance with a doctor or midwife for the conduct of her labour.

Doctor in Charge. When the patient books with him the doctor should examine her as he thinks necessary, and should continue during the rest of her pregnancy to supervise her general health and her obstetrical condition, making such further examinations as may seem to him requisite. At all his examinations he should be on the watch for signs in his patient which may threaten danger to herself or her child. Discovering such, he may treat her himself or send her to a prenatal clinic of the local authority or secure her admission to the prenatal ward of a maternity hospital. He is at liberty also to call in for his guidance any obstetrical specialist appointed for the purpose by the local authority. In conducting the labour he will require the assistance of a maternity nurse. She should be either a certified midwife or a registered general nurse or a woman certified by an approved hospital. In certain English districts, under an Order by the Minister of Health, these qualifications are compulsory for women acting as maternity nurses. If while he is conducting the labour his patient develops a grave emergency, he may again have recourse to the obstetrical specialist or seek the woman's admission to a maternity hospital. If during the puerperium he has occasion to diagnose puerperal pyrexia or puerperal fever it is his duty to notify the medical officer of health and his privilege to receive certain services in return. If ophthalmia occurs in the infant it is again his duty, in terms of the Ophthalmia Regulations, to notify the medical officer of health, who will, if desired by him, provide special treatment either at home or in hospital.

Midwife in Charge. In cases where an expectant mother wishes to be confined at home by a midwife she may be aided by the local authority to get one at a modified fee. Under the Midwives Act, 1936, local authorities must take steps to secure in their area an adequate number of whole-time certified midwives or maternity nurses, either themselves employing the midwives or nurses or arranging for their being provided by a welfare council or voluntary organisation. Arrangements must be made for refresher courses, which the midwives must attend. The local authority is required to fix scales of fees for the attendance of midwives and maternity nurses. The practice of midwives is controlled in general by the Midwives Acts and in detail by the Rules framed by the Central Midwives Board.

Acts. Under the Midwives Acts the central authority is the Central Midwives Board and the local authorities are the councils of counties and county boroughs. The Board frame rules for the training and examination of midwives, issue and cancel midwives' certificates and keep and publish the Midwives Roll. The local authorities are concerned with the midwives in their own areas. They report cases of misconduct to the Board and they may suspend midwives thought likely to spread infection. They must cause periodical inspection to be made of midwives' registers of cases and obstetrical appliances and equipment.

No woman may use the title of midwife without being certified under the Acts, and no person unless certified may attend a woman in childbirth otherwise than under medical direction and supervision. Students of medicine and pupil midwives are however exempt, as are also persons who can prove that the case attended was one of sudden or urgent necessity. It is the duty of every midwife to call a medical practitioner to her assistance on the occurrence of an emergency. The fee of the doctor attending in response to such a call is guaranteed by the local authority according to a scale.

Equivalent provisions are made in Scotland by the Central Midwives Board for Scotland.

Rules. The Rules framed by the Central Midwives Board define the emergencies on account of which the midwife is required to call in a registered medical practitioner. Examples of such emergencies are: when a woman during pregnancy, labour or lying-in appears to be dying or is dead: during *pregnancy*, when there is excessive sickness: during *labour*, when there is a presentation other than the uncomplicated head or breech: during *lying-in*, when there is a rise of temperature to 100·4° F. for 24 hours or its recurrence within that period, or a rise of temperature above 99·4° F. on three successive days: and in the case of the *child* when there is inflammation of, or discharge from, the eyes, however slight. Over thirty such conditions are listed. Further, the midwife must not make more internal examinations than are absolutely necessary, and she must not lay out a dead body except in the case of one of her own patients. She is also required by the Rules to notify the local authority: when she has called in medical aid: when she has laid out a dead body: when her patient dies: when a still birth occurs in the absence of a doctor: when she has been in contact with infection and when she proposes to substitute artificial for breast feeding.

The Rules of the Central Midwives Board for Scotland are substantially to the same purpose except that the crucial lying-in temperature is 100° F. only. Qualifying courses, arranged by the Royal College of Nursing, and comprising general hygiene, nutrition, administration, midwifery and babycraft, are available for those who wish to take the Midwife Teacher's examination of the Central Midwives Board.

Doctor-Midwife Combination. It has been recommended that in all cases where an expectant mother has engaged a midwife she should during her pregnancy be examined by a doctor with regard to her general health and her obstetrical condition on at least three occasions, the first of these to be about the 6th month of pregnancy, the second about 1 month before term and the third about 2 weeks before term. By means of these examinations untoward conditions may be revealed in the patient which would otherwise have escaped the midwife's notice and so lost the chance of correction. When discovered, such conditions may be treated by the examining doctor, or the patient may be referred to a clinic or sent to the prenatal ward of a maternity hospital. It has been further recommended that a month or more after the birth of the child, whether the labour was easy or complicated, the mother should again be examined by a doctor in order to note the degree of involution of the uterus and other evidences and advise accordingly.

Maternity Services (Scotland) Act, 1937. This Act brought the above-mentioned combination into effective practice in Scotland. It requires local authorities to make adequate arrangements for the provision to women, by whom or on whose behalf application is made, of the services in their own homes of certified midwives before and during childbirth and from time to time thereafter during a period not less than the lying-in period. To these ends the authority may engage with voluntary associations employing midwives or with midwives in private practice, or they may themselves employ midwives. Also every local authority must, when required, secure that for every woman, not being an in-patient in a hospital, by whom or on whose behalf application is made, there are available medical examination, treatment and supervision during the periods above specified, including the services of an anaesthetist when recommended by a practitioner or of an obstetrician where necessary and practicable.

Procedure under a scheme in conformity with the Act opens with an application by or on behalf of the expectant mother, a form for which she may obtain from the District Medical Officer. In the form she inscribes her name and address and the names and addresses of the practitioner and midwife of her choice, together with an undertaking on her part to comply with their instructions to her. The form on completion should be delivered or posted to the District Medical Officer. An explanatory note to the expectant mother, which is in use in a Scottish county, is helpfully appended to the application form. Thus:

'A list of the doctors and midwives available may be seen at the

2

residence of the District Medical Officer. The applicant after consulting the list should enter in the space provided the name of the doctor whose services she desires. Before entering his name she should obtain his consent.

'The applicant should obtain also the consent of the midwife whom she selects before entering the midwife's name in the form. If she cannot find a doctor or midwife willing to attend her she should inform the District Medical Officer.

'In the case of an insured woman, or the wife of an insured man, or of any woman who is in the County Council's opinion of similar economic status, the inclusive charge is £1 10s. In any other case the inclusive charge is £4. If the person from whom the charge is recoverable is in the opinion of the County Council unable to make any payment, or able to pay only a part of the amount due, the Council may waive or reduce the charge.'

For all the antenatal, intranatal and postpuerperal services to a case rendered by a practitioner in terms of the scheme, the practitioner's remuneration is £3 3s. This figure is reduced if the woman is removed to hospital before the commencement of labour and is delivered in hospital, or dies before the commencement of labour.

To a midwife in private practice, in respect for each case to which she has rendered the services required by the scheme, the sum of £2 15s. will be payable.

The Act, which applies to Scotland only, makes provision for the attendance of midwives at courses of instruction.

The Maternity Services (Scotland) Act, though repealed in parts by the National Health Service (Scotland) Act, 1947, will in the meantime continue in operation as set forth above. When the Appointed Day comes, the new Act will take over, providing services of an equivalent character to those now being given. The doctor-midwife combination will be preserved but, whereas in the old way the local authority supplied both the midwife and the doctor, in the new way the local health authority will supply the midwife only. The doctor will be provided from the general practitioner service which in future is to be administered by Executive Councils.

INSTITUTIONAL SERVICES

The welfare centre is the pivot institution for local authority welfare work. It usually houses the prenatal clinic for expectant mothers and the infant consultation clinic for nursing mothers and their infants. It may be combined also with the pre-school and school clinics. Typically it is non-residential, on the model, say, of the out-patient department of a voluntary hospital, but some infant clinics have a few observational cots attached. The centre may be equipped with apparatus for light therapy and radiography. It should have a lecture and demonstration room with projection facilities, in which instruction in mothercraft and kindred topics can be given. A perambulator shelter should be provided. Where the centre is not intended primarily to be a treatment unit it should give ready access to the dental, venereal disease, irradiation and other special clinics in the area, as well as to the local maternity hospital and the children's hospital. It should be under the charge of a medical officer of the local authority, who should act also as inspector of midwives; and local practitioners on part-time service may share in the work. The centre may also be a local station for the health visiting staff of the area, who will keep it in touch with the home conditions of the mothers and children attending. It should possess links on the one hand with public assistance and on the other with voluntary social workers. It is permissible at welfare centres to give advice on contraceptive methods to expectant or nursing mothers attending the centre who are married women, if it is thought that further pregnancies would be injurious to their health. Local authorities may establish gynaecological clinics also, at which similar advice may be given to married women in like circumstances.

The residential institutions under maternity and child welfare schemes include maternity hospitals and maternity homes: convalescent homes for infants and nursing mothers: homes for illegitimate children and their mothers: orthopaedic wards: puerperal sepsis wards: venereal diseases wards and hospital accommodation for the infectious diseases of children, including ophthalmia neonatorum. Local authorities may themselves provide and maintain institutions for all these purposes. For certain services they may find it more convenient to contract with the managers of voluntary institutions.

The services rendered by means of these various institutions, out-patient or residential, may be grouped as preventive of (1) maternal death and morbidity, (2) prenatal death, (3) infant death, and as (4) conducive to the welfare of pre-school children.

SERVICES FOR THE PREVENTION OF MATERNAL DEATH AND MORBIDITY

Maternal Mortality has hitherto been expressed as the number of maternal deaths per thousand live births. For England and Wales in 1911 the rate was 3·87: in 1935 it was 4·10, and in 1941 2·85. For Scotland the equivalent figures were 5·7, 6·3 and 4·9. Of recent years a slight downward tendency, more marked in England, has become apparent in both countries.[1] Lately the English Registrar General has expressed the rate also per thousand of all births including still births. Maternal mortality tends to be higher in unmarried mothers owing partly to inadequate or non-existent prenatal care, partly to the large proportion of first pregnancies among them. It steadily increases with advancing age. Recent work in Canada suggests that unbalanced or vitamin-poor diet increases obstetrical risk, and that supplemented diet noticeably lessens the incidence of miscarriage and prematurity. Social and sanitary conditions have in general little effect on maternal mortality one way or the other. Light work in factories by expectant mothers does not appear to be prejudicial, but rough hard work with heavy lifting, if continued to

[1] Page 24.

near term, is definitely harmful. It is injurious also for a woman to resume work too soon after the stress of labour. In terms of the Public Health Act, 1936, the occupier of a factory who knowingly allows a woman to be employed therein within 4 weeks after she has given birth to a child is liable to fine on conviction.

TABLE 1

MATERNAL MORTALITY RATES

Per Thousand Live Births

Year	England and Wales	Scotland
1911	3·87	5·7
1912	3·98	5·5
1913	3·96	5·9
1914	4·17	6·0
1915	4·18	6·1
1916	4·12	5·7
1917	3·89	5·9
1918	3·79	7·0
1919	4·37	6·2
1920	4·33	6·2
1921	3·91	6·4
1922	3·81	6·6
1923	3·81	6·4
1924	3·90	5·8
1925	4·08	6·2
1926	4·12	6·4
1927	4·11	6·4
1928	4·42	7·0
1929	4·34	6·9
1930	4·40	6·9
1931	4·11	5·9
1932	4·21	6·3
1933	4·51	5·9
1934	4·60	6·2
1935	4·10	6·3
1936	3·80	5·5
1937	3·26	4·8
1938	3·08	4·9
1939	2·93	4·5
1940	2·70	4·4
1941	2·85	4·9
1942	2·47	4·1
1943	2·30	3·8
1944	1·93	3·0
1945	1·80	2·8

Maternal Morbidity. While figures can be stated for the frequency of maternal deaths we have, except for the notifications of puerperal fever and puerperal pyrexia, which cover only a part of the field, no corresponding data for puerperal morbidity. The actual amount is difficult to assess but it is well known to be substantial. J. M. Munro Kerr gives toxaemia, infection and trauma as the three outstanding causative factors of the disablements resulting from pregnancy and childbirth. The administrative measures to prevent maternal morbidity are the same as those employed for the prevention of maternal death.

Preventive Action directed against maternal death and morbidity begins with the prenatal examination of the expectant mother with regard to her general health and her obstetrical condition in a prenatal clinic or elsewhere: it continues thereafter throughout her pregnancy up to full term: is intensified during labour and should not be relaxed during lying-in. Records have been produced to show that by the adequate use of an efficient prenatal service, followed by the competent management of labour and the puerperium, the incidence of maternal death can be reduced to the vanishing point.

The disease conditions mainly responsible for maternal death or morbidity are (1) Toxaemia of Pregnancy and (2) Puerperal Sepsis.

Toxaemia leads to one-sixth of the total maternal deaths. If its warning signals, such as albuminuria and rising blood pressure, are detected in the expectant mother at a prenatal examination, she should be put under treatment or may be sent for observation and treatment to the prenatal ward of a maternity hospital. Cases taken in hand thus early usually do well. It was observed by the Departmental Committee which reported in 1932 that there was a 'primary avoidable factor' in 73 per cent. of the cases dying of eclampsia.

Puerperal Sepsis is the cause of one-third of all the maternal deaths. It is the result of the implantation of pathogenic bacteria on the denuded placental site, or a puerperal laceration. In sepsis after normal labour the haemolytic streptococcus is the predominant agent. Infection is believed to take place either during or after labour, and to originate from the noses or throats of persons in attendance, being conveyed from there direct to the vulva by the spray infection or by the intermediary agency of someone's hands or instruments, or else by first invading the nose or throat of the patient herself and passing thence to her handkerchief, then her hands, and so to the genitalia. In sepsis after a labour which has been attended by injury, while streptococcus pyogenes strains *ab extero* are often implicated, endogenous infection may also occur by anaerobic streptococci or the colon bacillus or other organisms deriving from the intestine or septic foci.

The Departmental Committee reported also that there was a 'primary avoidable factor' in 59 per cent. of the cases dying of puerperal sepsis. Among such factors may be the presence in the woman of septic foci round carious teeth or of gonorrhoea. The examination of the expectant mother at a prenatal clinic may bring these factors to light, and their subsequent elimination by treatment at an appropriate clinic has a preventive value against puerperal sepsis. Or else the expectant mother may exhibit a malpresentation or other abnormal state which portends dystokia. It will then be endeavoured to correct the untoward condition and so make labour easy, which is not only good in itself but is also preventive of puerperal sepsis, of which difficult labour is a predisposing cause.

In maternity hospitals routine bacteriological examinations should be made of the throats and noses of nurses and others for *Streptococcus* *pyogenes*. The perineal toilet of lying-in patients should be carried out with strict asepsis. It has been recommended that labour rooms should be air-conditioned, that during the conduct of labour all persons attending in the labour room should wear gauze and cellophane masks, that operators should make use of rubber gloves and that speech in the labour room should be discouraged. It has been further advised that in normal cases vaginal examinations should be avoided after the membranes have ruptured. General ward measures for the prevention of cross infection in maternity units are as noted below.[1] The risks of bacterial infection and the paths of its transmission should be clearly explained to the staff, and illustrated by practical demonstrations such as the inoculation of solid culture media by unsterilised dressings and by the uncleansed fingers. The bacterial growths resulting from these experiments will tell their own tale.

Another suggestion is that, in order to prevent future hardship, pupil midwives should be examined clinically, and those with chronic streptococcal infections of the tonsils or sinuses should be advised that such persistent infection is likely to debar them from the practice of midwifery. Haemolytic organisms of the Lancefield Group A are the most likely to cause puerperal infection, though Groups B, C and G are not without danger.

When streptococcal infection shows itself in a maternity unit the patients should immediately be isolated and all other patients in the ward thoroughly examined for the presence of conditions productive of haemolytic streptococci. Such are tonsillitis, scarlet fever, acute rhinitis, otitis media, erysipelas and cutaneous and other sepsis. All patients yielding organisms of the Lancefield A variety should be nursed in isolation, either by the open or by the cell technique,[2] and should not be released until not less than two bacteriological examinations at three-day intervals have proved negative. Only nearest relatives should be permitted to visit the ward and then only at the discretion of the sister. During the period when secondary cases may be expected, patients should be kept in bed and examined daily for prodromal signs.

Good results follow the use of *p*-aminobenzene-sulphonamide in streptococcal puerperal infections and complications of the puerperium. The drug is administered orally or, in severe cases, intravenously. It is now recommended, in modified dose, as a prophylactic for women in labour, and before dental extraction late in pregnancy, where there is a possible risk of haemolytic infection. The substance is known also as sulphonamide-*p*, sulphanilamide, or by such proprietary names as 'prontosil album,' 'streptocide,' 'proseptine' and 'stramide.'

Puerperal Pyrexia. In terms of regulations made in 1926, cases of puerperal fever and puerperal pyrexia are required to be notified by medical practitioners to the medical officer of health. Puerperal pyrexia is defined in the regulations as 'any febrile condition, other than a condition which is required to be notified as puerperal fever, occurring in a woman within 21 days after childbirth or miscarriage, in which a temperature of 100·4° F. or more has been sustained during a period of 24 hours, or has recurred during that period.' In the special notification form the practitioner is given the opportunity to enter in the space provided that he desires (1) to have a second opinion on the case, or (2) to have a bacteriological examination made of lochia or blood, or (3) to have the patient admitted to hospital, or (4) to have a trained nurse provided for her. The fee for notification is 2s. 6d.

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[1] Page 422.

[2] Page 390.

The notification of puerperal fever or puerperal pyrexia in this manner and on these terms brings the patient within reach of the diagnostic and remedial facilities provided by the local authority, which in cases of puerperal pyrexia has a clear preventive value inasmuch as it enables treatment to be begun in the early stages of what might otherwise develop into declared puerperal sepsis.

Abortion. The number of criminal abortions occurring annually in Great Britain has been estimated at 50,000. Thirteen per cent. of the maternal deaths in the country are caused by abortion, and 70 per cent. of the deaths from abortion are due to sepsis. A recent study of 1000 cases showed that criminal interference was responsible for most of the deaths which occurred. It is said that the women who suffer from chronic pelvic inflammation as a result of criminal abortion outnumber those who die. Records suggest that some increase of the practice of criminal abortion has occurred lately in England. It seems unlikely that the introduction of the notification of abortion would have much effect in bringing criminal cases to light. Under the Pharmacy and Medicines Act, 1941, it is an offence to publish advertisements referring to any articles in terms calculated to lead to their use as abortifacients. In England the Law regards the induction of abortion as a crime which may be justifiable by medical reasons. No practitioner should proceed to induce abortion without previous consultation with another medical person.

In 1920, when war, famine and fever together were rendering living conditions well nigh desperate in Russia, abortions were of frequent occurrence either spontaneously or after clandestine interference by unskilled persons, and the Government determined that, if there must be abortions, they should take place in a safe environment. A law was accordingly framed declaring the operation for abortion legal if performed up to the twelfth week of pregnancy in a hospital by a physician. By 1936 the cloud had lifted. Food was again adequate, wages were high, and every second child was being born in a maternity home. Nurses were plentiful and a beginning had been made with family allowances. Abortion being no longer inevitable, the Law legalising it was repealed.

Maternity Beds. The number of maternity beds which should be provided in areas has been variously stated. One bed per 7000 of population has been proposed for general use, but in industrial areas 1 per 2000 may be the proportion. In the recent Report of the Sub-Committee on Infant Mortality in Scotland 45 beds per thousand total annual births is given as a minimum provision. In residential urban areas 3 per cent. of cases may go to hospital and in densely populous areas 20 to 30 per cent. The types of case for which beds are required are (I) prenatal cases who are taken in for observation and treatment in a prenatal ward and (II) puerperal cases, whose labour is impending or actually in progress. The puerperal cases may be either (1) Prenatally treated cases admitted before labour begins, (2) Emergency cases which while in labour at home have developed a complication, (3) Cases of necessity, coming from homes which lack facilities for the conduct of labour, and (4) Cases of election, who on the ground of convenience or in the belief that the institution is more resourceful than the home, elect to be delivered in a hospital or its equivalent. The relative proportions of groups (1) to (4) will vary from area to area. Group (1) will be high where prenatal care is efficiently given. Group (2), the emergency cases, will be high where prenatal care is inadequate. Many of these emergency cases may be such as to threaten sepsis. They should be placed in a 'suspect' ward or in one-bed cubicles for a week or more. These, and all similar cases, should they develop sepsis, must at once be removed to isolation, preferably in a fever hospital or equivalent institution. Group (3) will be high in hospitals which serve poor areas. The proportions of group (4) will depend upon the prevailing usage. In Stockholm 90 per cent. of the labours are institutional. In this country at the present time there is a tendency for the proportion of such cases to increase. The suggestion has been made that all primigravidae should be admitted to hospital. It has been further proposed by some that all deliveries should be institutional, but the bed-strength quoted earlier in this paragraph from the report of the Sub-Committee on Infant Mortality should be sufficient to meet all reasonable demands.

Co-ordinated Service. A scheme for a co-ordinated maternity service on a national basis should provide for the division of the country into appropriate obstetrical service districts each with its obstetrical headquarters in the principal town. Each obstetrical service district should be divided into sub-districts each with its local obstetrical centre. The obstetrical headquarters would be made up of the headquarters prenatal and maternity bed units, staffed by obstetrical specialists and complete with laboratory and other equipment, together with the headquarters clinic, to which selected prenatal cases would be referred from the local obstetrical centres. In principal towns where there is a medical school the obstetrical headquarters and the medical school should be administratively linked to one another, for mutual advantage. Each local obstetrical centre would consist of a maternity hospital or a hospital including maternity beds, together with the local clinic or clinics. The local centre, while in touch on the one hand with the obstetrical headquarters, would on the other hand keep close relations with local domestic midwifery practice, and its staff would be available, for first-instance consultation and operation in suitable cases, to medical men either carrying on sole-charge midwifery in the area or called in by midwives under a doctor-midwife combination arrangement. It would be essential that transport by motor ambulance should be fully organised, including, in difficult counties, transport by air.

Physique of Mothers. The general health and nutritional state of expectant mothers come under close attention at prenatal clinics. An additional ration of milk may be issued to them and also an allowance of such foods as green vegetables, eggs, fruit, fish liver oil and vitamin concentrates. The basic factor in maternity however is the physical constitution of the woman, which cannot be extemporised for the occasion but is determined in great measure by her previous nurture through infancy, girlhood and adolescence. It is noted by the Departmental Committee already referred to that in countries where habits of life are wholesome, where opportunities for outdoor exercise are ample, and where the customary diet is rounded off with a proper consumption of milk, the women are physically well developed, their skeletal foundations sound and their maternal mortality in consequence low. The cult of physical fitness now inaugurated in this country may evolve a type of womanhood more robust in the essentials. It is a good augury that the British maternal mortality rates, so long refractory, have lately been declining.

SERVICES FOR THE PREVENTION OF PRENATAL DEATH

Prenatal Death may be either (1) abortion or (2) still birth. It is abortion up to but excluding the 8th lunar month of pregnancy. Still birth is the dead birth of a viable child, from the beginning of the 8th lunar month, whether premature or full-term. Pre-natal mortality is expressed per thousand live births. The frequency of recognisable abortion has been conjecturally put at 180 per thousand live births. Still births, being notifiable and registrable in England and Wales and Scotland, are known and recorded. They amount on average to 30 per thousand live births. The dominant cause of still birth is dystokia with its complications, the most formidable of which are intra partum asphyxia and cerebral haemorrhage, the former apt to ensue on breech presentation or prolonged second stage, the latter on breech presentation, podalic version or forceps delivery. Premature children are specially liable to cerebral haemorrhage. Among the causes of the remaining deaths syphilis is outstanding, followed at a little distance by the toxaemias of pregnancy. Social factors may be not unrelated to prenatal mortality. In poor quarters a high still-birth rate has been observed. Social investigation has shown that heavy domestic work, such for example as house cleaning in preparation for the confinement, may induce physical exhaustion with consequent dystokia. A régime of rest and quiet during two to three weeks immediately preceding the labour is therefore to be advocated.

Preventive Action against prenatal death begins with the prenatal examination of the expectant mother at a prenatal clinic with regard to her general health and her obstetrical condition. The proper function of this clinic is that of an outpost of the maternity hospital, or the obstetrical unit of a general hospital. Ideally it should be directed and administered by the specialised staff of the unit. On this plan the desired co-ordination of antenatal and obstetrical services can readily be effected. Hospital records show that cases which had received prenatal treatment in the wards have more live-born children than cases admitted in emergency and seen for the first time.

Dystokia. If the expectant mother is found to show the warning signs of difficult labour or any of its special complications, steps are taken with the object of curing or alleviating the departure from the normal, so that labour may result in a live and healthy child. Contracted pelvis, mainly rachitic in origin, is still an important cause of dystokia, even when of slight degree, and its early recognition is therefore an essential in predicting difficult labour. There is on this account a need for accurate antenatal pelvimetry both by manual and by skiagraphic methods. In hospital practice it is now regarded as advisable that the services of a radiologist should be available not only for antenatal diagnosis but also, in special cases, while the patient is in labour.

Syphilis. An expectant mother if found syphilitic may be treated either at the clinic or, if sent to a venereal diseases clinic, treated in a special section so that she need not mix with the other patients. Syphilis is an eminently preventable cause of prenatal death. Syphilitic women, if untreated, may have 60 per cent. of still births : with syphilitic women who have been treated sufficiently early the proportion will fall to 5 per cent. or lower.

Toxaemia which causes the death of the mother is usually fatal to her child also. The control of the condition is dealt with above in connection with maternal mortality.

Gonorrhoea of the mother, though rarely fatal to the infant, may set up ophthalmia neonatorum, of which it is the principal cause, and lead to blindness. Preventive action begins prenatally. The expectant mother found at a prenatal clinic to be suffering from gonorrhoea is either treated at the welfare centre or else sent to a venereal diseases clinic where, as for syphilis, she may undergo her treatment in a special section. Intra-partum prophylaxis is put into operation immediately after the emergence of the head. The rules framed by the Central Midwives Board require the midwife to carry in her bag an efficient antiseptic for cleansing the infant's eyelids. As soon as the child's head is born, and if possible before the eyes are opened, the eyelids must be carefully cleansed, using separate pieces of clean material for each eye.

The Central Midwives Board for Scotland then require the midwife after very gently separating the eyelids to drop within the opening of the lids one or two drops of a 1 per cent. solution of silver nitrate or other approved preparation such as protargol.

If, despite all precautions taken, the midwife notices any inflammation of, or discharge from, the eyes, however slight, it is an emergency as defined by the Board, and her duty is to call in medical aid.

Ophthalmia Neonatorum. Ophthalmia of the new born is notifiable by medical practitioners to the medical officer of the child welfare authority in terms of the Ophthalmia Neonatorum Regulations of 1926. The disease is defined in the Regulations as 'a purulent discharge from the eyes commencing within 21 days from the date of birth.'

Similar provisions are made for Scotland under the Infectious Diseases Regulations of 1932.

Immediately on receipt of the notification, treatment should be initiated by the local authority, either at home by a nurse or health visitor specially trained, or in a hospital to which both mother and child may be removed and at which the services of a consulting ophthalmologist should be available. When a medical practitioner is already in attendance upon the case his co-operation should be sought in the treatment. Ophthalmia neonatorum is declining in frequency at the present time, though some thousands of cases are still notified annually. Gonorrhoeal ophthalmia may now be treated by small oral doses of sulphapyridine or a kindred sulphonamide. Good results are also claimed for the local application of penicillin both in the gonococcal and non-specific forms of the disease.

Prematurity. The incidence of premature birth shows considerable local variation, ranging from 5 to 11 per cent. of total live births. Its causes include multiple pregnancy, chronic maternal disease, untimely separation of the placenta and foetal deformity.

Arrangements for the care of premature infants are now engaging the attention of local authorities and it has been officially suggested that institutional accommodation should be provided at maternity hospitals for such cases in the proportion of 10 prematurity cots to every 100 maternity beds. This provision may be made either in special incubator wards with temperature maintained at 80° to 90° F., or in normal air-conditioned and humidified wards, open or cubicle, with individually warmed cots. Special transport with heated carrying apparatus is required to bring the infants from their homes to the prematurity ward. It has been further suggested that, in cases where the removal of the premature child from its home is undesirable or impracticable, the welfare authority should issue equipment for its home care, including a metal draught-proof cot, an electrically heated blanket, an oxygen cylinder, mucus catheters and special feeding bottles. The child welfare medical officer will decide in consultation with the general practitioner or midwife in attendance whether the infant should be nursed at home or be removed to hospital. The premature infant is especially liable to infections such as septicaemia, pemphigus and gastro-enteritis. Among precautions which may be taken to avoid these risks are the wearing of masks by nursing staffs, the use of spindle oil as a dust repellent on ward floors and furniture, the ultra-violet irradiation of the ward air, and the exclusion of visitors.

Neonatal Deaths. Infants which have been subjected to the severest stresses of labour are usually born dead. Others, less severely but nevertheless mortally injured, may be born alive but die within the first month of independent existence. These are the neonatal deaths, due to the same causes as the prenatal deaths and equal to them in frequency, namely, 30 per thousand live births. Still others may survive and pass on into life with their damaged brains. They are recognised before long as different from other babies and later may have to be classed as idiots or imbeciles. Prenatal care may thus extend its protective influences over a much wider field than that of prenatal death.

Services for the Prevention of Infant Death

Infant Mortality. For statistical purposes an infant is a child under the age of 1 year. The infant mortality rate is conventionally expressed as the number of deaths of infants in any year per thousand live births occurring in the same year. The infants who die and those who are born are not necessarily the same, but for general purposes the method is accurate enough. A sudden rise in the number of births however, as happened after the First World War, may cause the conventional infant mortality rate to work out too low. Such a discrepancy may be corrected by relating the deaths of the infants to the births of the quarter of the year in which they were born. Infant mortality is higher throughout for boys than for girls. It includes the neonatal deaths which occur in the first month of life and as already noted are mainly due to prenatal causes. They constitute some 40 per cent. of the total infant deaths. Respiratory diseases and gastro-enteritis together account for half the rest. A recent survey has shown that the infant death rate from respiratory and gastro-intestinal infections is higher in Scotland than in England and Wales, and shows a degree of correlation with low environmental conditions.

Social Factors. Infant mortality as a whole, the neonatal deaths excepted, differs from prenatal or maternal mortality in that it is closely related to social conditions. The basic requirement of infancy is efficient maternal care, and circumstances which react in restraint of that care are unfavourable to infants, whence infant mortality. There is, for example, a high mortality among illegitimate infants, who are usually committed to the care of strangers. On the other hand industrial work by mothers does not appear in general to be a cause of infant death, presumably because the mother's work brings added prosperity and comfort to the home. Poverty *per se* does not entail high infant mortality. In times of food shortage or other hardship it has been observed that the infant death rate falls, possibly owing to the increase of breast feeding under such conditions. Wages alone are not decisive. In country districts, where wages are low, the infant mortality is low also: among low-paid workers in towns it is high, the reason being that they usually live in crowded quarters where the adequate care of infants is an arduous task. In the same way structurally defective houses are not necessarily injurious. Infants nurtured in such houses in the country may do quite well: in towns, where houses of this type are usually overcrowded, the infant mortality rate is high. As regards the method of feeding adopted, it is agreed by all that breast feeding is better than hand feeding. Countries and communities where breast feeding is the rule have low infant mortality rates. Where hand feeding has to be, or is, adopted, it is easy enough under decent living conditions to take all the necessary precautions: it is difficult in cramped and overcrowded dwellings, especially where the infant is the last, for the time being, of a large family. Ill-health of the mother, or her ignorance of mothercraft, or her general incompetence as a manager, will obviously under any conditions tend to incline the balance against the infant, but even where the mother knows what to do and is willing to do it the social conditions under which she is living may hamper her every effort. It has been well said that its infant mortality rate is a reliable indicator of the social progress or stagnation of a locality.

Infant Services. As a result of the compulsory notification of births[1] the medical officer of health receives timely information of all births occurring in his area and the addresses at which they occurred. If it has been a midwife's delivery he sends a health visitor to the house to ascertain the state of the child. If it is a doctor's case the visit is usually delayed until such time as the doctor shall have ceased attendance. The health visitor invites the mother to bring her baby to an infant consultation clinic. Here the child is weighed at regular intervals and kept under observation. The mother receives instruction in mothercraft, including breast feeding. She gets advice on her infant's clothes, their pattern, material and putting-on, and is usually able to purchase at the clinic good styles in baby wear at low prices. It is not necessary that the medical officer of the centre should see the healthy infant on each of its weekly appearances. Weighing, measuring and normal feeding questions are best dealt with by the nurse, and the doctor should enter upon the scene only when his professional advice is sought, when immuno-prophylaxis is requested or when the nurse considers that a medical opinion is desirable. The doctor may, however, in group talks to mothers, fill the preventive and educational rôles which are paramount in the conservation of child health.

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[1] Page 35.

Often the child's minor ailments are treated at the consultation clinic, and infant vaccination provided free of charge, if desired. Infants requiring more extended treatment may be referred to the family doctor or to a treatment clinic. The health and nutrition of the nursing mother are attentively supervised in the interests of both her child and herself. If the suckling shows signs of losing condition, under-nourishment of the mother may be the cause. She may then receive an issue of milk and food or be sent with her infant to a convalescent home. The work of the clinic should be backed on the one hand by the attention of health visitors, or voluntary associates, to the homes of the infants with the view of aiding mothers to render the home conditions as suitable as may be for the nurture of infancy, and on the other hand by an adequate provision of hospital beds for infants.

As shown in the Table[1] the infant mortality rate for both England and Wales and Scotland has notably decreased since 1900. For the decline since 1915 the infant services of local authorities may justly claim a share of credit. The mothercraft instilled at the clinics may well have served for the defence of infants against gastro-enteritis and bronchitis, the recession of which over the period has been among the most substantial. It should be noted that the neonatal deaths stand aloof from the general betterment. Their reduction has been comparatively small.

These things being so, it will be apparent that among the principal lines along which further progress for the reduction of infant mortality may be expected to be made are (1) increased prenatal care, for the prophylaxis of the neonatal deaths: (2) a more widely disseminated understanding of mothercraft: and (3) the abolition of overcrowding and squalor so that mothercraft may have a chance.

Instruction in mothercraft may be given, as noted above, to expectant and nursing mothers by trained health visitors at the welfare centres.

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[1] Page 156.

'Talks to Mothers' by well-known specialists, either broadcast or printed in booklet form or as articles in periodicals, will reach a wider public. For intending mothers more systematic courses are desirable, and such have been instituted in Glasgow under the adult education movement. The lectures, by a medical woman, include the

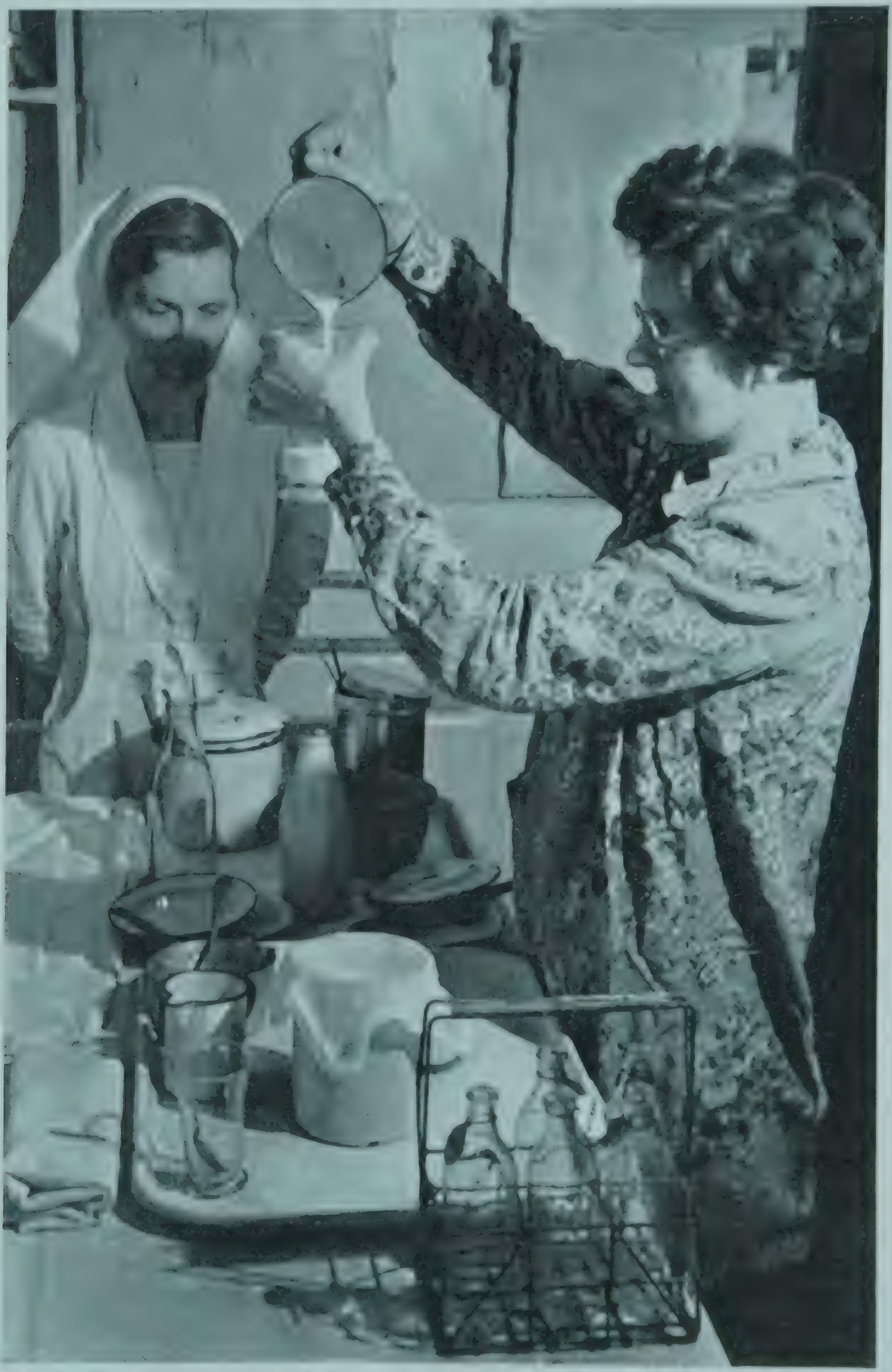

Fig. 8.—Technique of the preparation of infant feeds being taught at a mothercraft class.

hygiene of pregnancy, the preparations for confinement, and the care of the new-born, the suckling and the pre-school child. Practical work in handling babies forms part of the scheme and cinematograph displays drive the lesson home.

Mothercraft is now taught also to girls in junior secondary and higher grade schools as part of the course in housewifery. The instructress may be a domestic science teacher who has been appropriately trained or, better, a maternity nurse or health visitor may be seconded for the duty. The courses deal with the bathing, dressing and feeding (Fig. 8) of infants and may include personal hygiene and the care of the sick. Practical experience is gained at day nurseries, nursery schools and child welfare centres. There should be no elaboration of the physiology of pregnancy in such courses.

It may be added that the Sub-Committee on Infant Mortality in Scotland say in their report that 'the education of mothers in infant feeding and domestic hygiene is of paramount importance.'

Notification of Births. In terms of the Public Health Act, 1936, the birth of every child born after the 28th week of pregnancy, whether alive or dead, must be notified to the medical officer of health of the welfare authority by the father, if resident at the time of birth on the premises where the birth takes place, and by any person who has, at the time of or within 6 hours after the birth, been in attendance on the mother.

Notification is to be made by posting within 36 hours a prepaid letter or post card or by delivering within that period a written notice. The welfare authority must supply, free of charge on application, addressed and stamped post cards, displaying the form of notification, to any medical practitioner or midwife residing or practising in their area.

The penalty for default is up to twenty shillings unless the person can satisfy the Court that he had reason to believe that notice had been given by someone else.

The notification is in addition to, and not in lieu of, registration of the birth with the registrar. The notices of births received by a medical officer of health are to be accessible at all reasonable times to the registrar.

The same provisions apply to Scotland in terms of the Notification of Births Act, 1907.

SERVICES CONDUCIVE TO THE WELFARE OF PRE-SCHOOL CHILDREN

Pre-school children fill the span between the beginning of the second year of life and the close of the fourth. They present a wide field for necessary action by reason not only of their numbers but also of their needs.

While infants are born with some degree of immunity and lead sheltered lives, pre-school children are exposed to the full force of the common infectious diseases. Pneumonia, measles and whooping cough are specially fatal to them. They may suffer also from rickets, early rheumatism and dental caries. They may develop external eye diseases, faults of vision including strabismus, and postural errors. In crowded homes they undergo repeated attacks of the catarrhal affections of the upper respiratory tract. Their lymphoid tissues hypertrophy, their tonsils enlarge and become septic, and the mischief may spread to the middle ear leading to ear discharge. At night they suffer from lack of sleep, being put to bed late, and even then kept awake by the talk, bright lights and other distractions of the family living room. Where younger babies claim the mother's prior attention, pre-school children are apt to be a burden to themselves and others. There is no nursery for them indoors. If they go out into the court-yard they are too small to play with the older children, so that they spend much of their time hanging about on tired legs and unhappy in their minds.

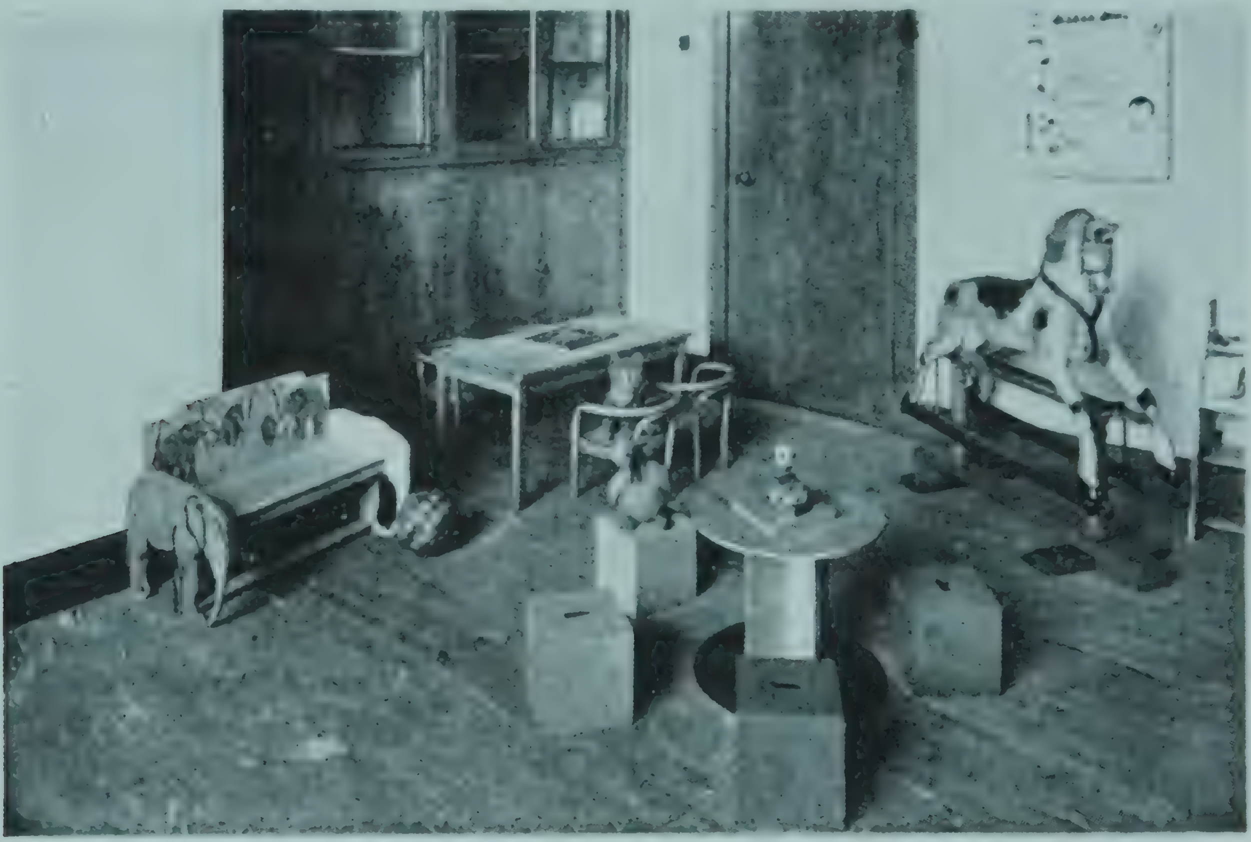

Fig. 9.—Play Room, Day Nursery.

Effort has begun to be made for the control of these conditions. That further effort is needed is shown by the considerable number of defects which continue to be found in children entering school. The provisions made in pre-school service schemes include pre-school welfare clinics, day nurseries, nursery schools and nursery classes.

Pre-School Clinic. Where a special clinic is established for pre-school children, its structure, equipment and conduct are similar to those of the out-patient department of a children's hospital. Where a special clinic is not established, arrangements should be made for the work to be done at such a department. Mothers who are regular in bringing their infants to welfare centres are apt to bring their pre-school children only in case of illness. The visitation by health visitors of homes where there are children is of great service in promoting attendance at pre-school clinics. The clinics should be in touch with children's hospitals, general treatment clinics, orthopaedic, actinotherapy and dental clinics, as well as with ophthalmic clinics which provide for the cure of squint.

Day Nursery. A day nursery or *crèche* is a place where mothers who have to go out to work or to procure the family rations may leave their children during the day or night or during some hours of the day or night. The infants are usually kept separate from the two-year-olds. The children are medically examined on admission, inspected daily for signs of infection and weighed weekly. Being fed and bathed, sleeping and playing fill up their day. Thirty children is the normal complement for a day nursery, and 60 the limit.

The premises for the day nursery should be situated in a reasonably quiet locality. They should possess a grass or asphalt playground equipped with 'developer' apparatus including swings, a chute and a jungle-gym. A sand pile, with wooden spades and buckets, is appreciated by the younger children. The rooms should be light and airy and should permit of cross-ventilation. Fires and central heating pipes should be efficiently guarded. Stairways are best avoided but if present they should be fitted with baffle gates. Furniture should be of the simplest, and beds are best of the 'camp' type. Isolation and laundry rooms and a cool milk larder should be provided. Individual towels, face cloths, combs and tooth-brushes, with appropriate storage racks, are essential and each child should have its own play overall and plimsolls, for which separate pegs and shoe pens are required. The playroom (Fig. 9) is an important feature of the nursery. It should contain a piano or gramophone for action songs and musical games. A good supply of paper handkerchiefs should be available. There must be ample toilet accommodation with abundance of hot water and sanitary fixtures adapted for small children (Fig. 10). Toys should include soft dolls, building bricks, modelling material, crayons and blackboards. Mechanical and metal toys should be avoided. All rooms, equipment and clothing should periodically be disinfected.

The matron-in-charge should be a State Registered Nurse and should preferably possess also the advanced certificate of the National Society of Day Nurseries or a certificate from an approved Nursery Training College. The remaining staff should be either nursery-trained assistants or probationers. The National Society of Day Nurseries grants a diploma to students after a training course of 2 years, which includes instruction in hygiene, infectious disease, child psychology, first aid and sick nursing, together with six months practical training at a nursery. A trained infant teacher should be allocated for children of the 2 to 5 age group. An adequate domestic staff should be engaged. The professional staff may be augmented by personnel of the Child Care Reserve established by the National Council for Maternity and Child Welfare.

Residential nurseries are available for young children whose mothers are about to be confined or are entering hospital for other reasons, for illegitimate infants during the period of maternal rehabilitation, for babies requiring skilled dietetic care, and for deserted children pending their adoption. In its construction and layout the residential nursery resembles the day institution. It should be staffed in the ratio of 1 nurse to every 3 children under two years, and 1 nurse for every 6 children between the ages of two and five.

The fate of the many war-time day nurseries is not yet decided. Their costs are heavy, they are not altogether free from the risk of infection, and they are alleged by some further to imperil our already undermined family life. On these and other accounts they have been adversely criticised. They have, nevertheless, done excellent work, and their possible *rôle* within the framework of the peacetime child welfare services requires a careful examination. Most authorities are agreed that there is a place in health services for the combined nursery school and

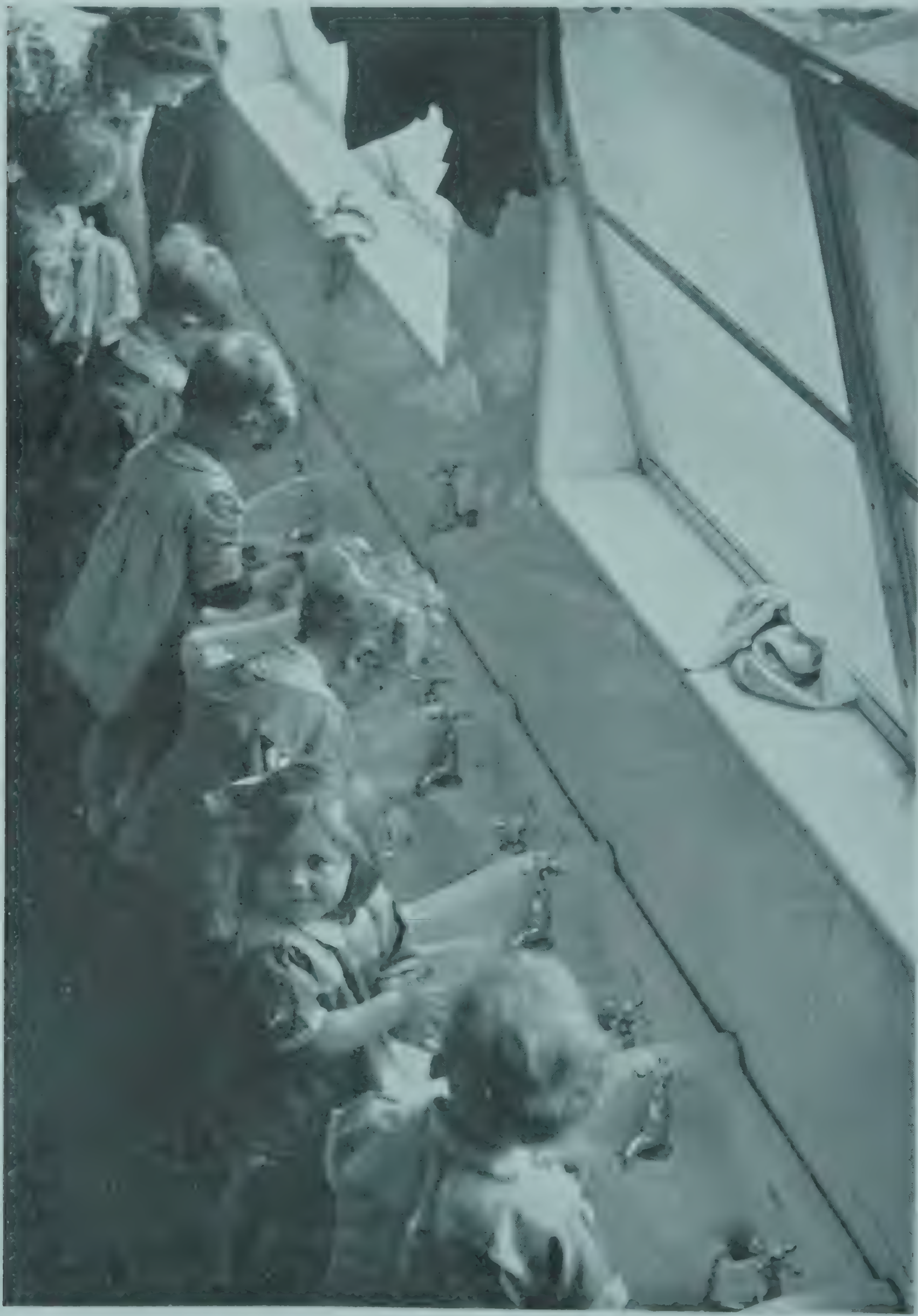

Fig. 10.—Hand-Washing under supervision at a day nursery. The basins are specially designed for the use of children.

crèche and the residential nursery. It is more than likely that they will figure in child welfare schemes of the future.

Nursery School. The nursery school is controlled by the Education Authority. The ages of the children attending are over 2 years but under 5. The capacity of a school may range from 80 children upwards.

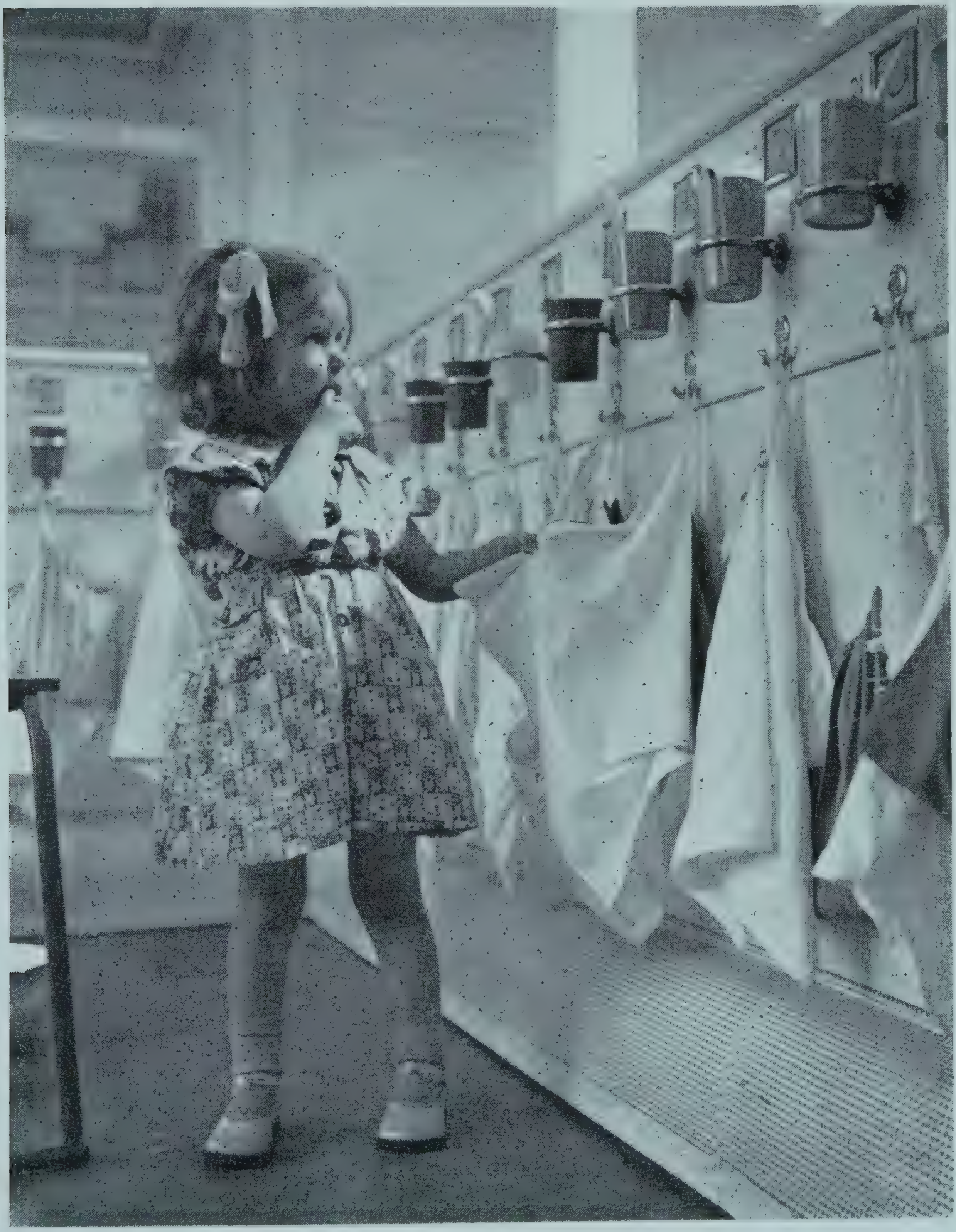

Fig. 11.—Individual toilet requisites at a nursery school. Protected central heating at floor level.

Each unit of 40 children is usually under the charge of a certificated teacher aided by probationers.

A nursery school should be as near as possible to its area of service. Buildings in or adjacent to crowded districts have been school-reconditioned with satisfactory results. Where a spacious vacant site is available the new school erected upon it should be of the one-storey open-air pattern, its class rooms having sliding roofs and folding sides. Glass-roofed verandahs may be provided instead or in addition. Central or other systems may be used for heating. Class rooms should allow not less than 15 square feet of floor space per child. Small wash-hand basins should be in the proportion of one to every 6 children, of w.cs. one to every 10 and a bath for every 40. Hot and cold water should be laid on, and means provided for drying wet clothes. The cloak room pegs should be not more than 3 feet from the floor with 12 inches between.

A school medical officer of the authority should examine all children prior to admission, the parents being present if possible on the occasion. He should also visit the school at regular intervals. A daily inspection of all children should be made by the school nurse. Health progress should be recorded and a look-out kept for defects or deformities.

Each child should have his own portable stretcher bed for the afternoon sleep. Also his own towel, tooth brush and other equipment (Fig. 11). The usual meals are breakfast, dinner and tea. The diet should be balanced, a milk ration being included, while cod liver oil and special foods are issued as required.

Formal education in the nursery school is of the slightest. The children may be taught to colour-in outline drawings with chalks. But order and routine are observed, and the children's activities guided, with approval or repression as may be appropriate. The effort is made to establish health-promoting habits. Group singing and organised action games have an educative value by pointing the lesson to the child that there are others besides himself who have a share in his small world. The nursery school age is impressionable. As these early impressions are often lasting it is important that they should be edifying. Something in the way of character formation may begin in the nursery school.

When first introduced the nursery school was intended for children under 5 whose mothers for some good reason were unable to give them at home the attention they needed. They were then a comparatively small group, the great majority of the others under 5 being presumed to be adequately nurtured at home under parental care. Now, under post-war conditions, the balance of the two groups has been, if not reversed, at least greatly altered. The widespread employment of mothers with young children has, together with other causes, deranged the general home life to such an extent that parental care in some areas is approaching eclipse, and the one time small group not receiving attention at home has swelled to disquieting dimensions. For the relief of these social orphans an enlarged development of nursery schools in the areas affected is required at this time.

It has been suggested that the nursery school should become a normal constituent of the educational course, attendance being made compulsory. The proposal that the age for admission should be lowered to infancy is not so good.

Nursery Class. The nursery class is attached to the infant department of a school. It is for children of the same ages as those who attend nursery schools and provides the same type of service, but no meals. During the war years children under the age of 3 were admitted to nursery classes but it is now considered inadvisable to continue this practice.

A pre-school welfare scheme should include also an adequate provision of hospital beds for the treatment of both ordinary disease conditions and the specific fevers.

CHILD PROTECTION

Provisions for the protection of children are contained in the Adoption of Children Act, 1926: the Children and Young Persons Act, 1933: the Public Health Act, 1936: the Adoption of Children (Regulation) Act, 1939: and the Education Act, 1944. In Scotland the Children and Young Persons Act is dated 1937.

Adopted Children. Under the Adoption of Children Act adoption orders may be made by certain Courts. Before making an order the Court must be satisfied that the order, if made, will be in the interests of the child, and that there is no question of any payment or reward to the person adopting other than what the Court may sanction. Under the Adoption of Children (Regulation) Act the Secretary of State may make regulations for the conduct of negotiations with reference to adoption. No body of persons other than a registered adoption society, which must be a charitable association, or a local authority, may make any arrangements for the adoption of a child. When the arrangements are duly completed the child is delivered into the care of the prospective adopter. Three months later, if neither party to the arrangements has given written notice to the other that he or they do not intend the adoption to proceed, the prospective adopter may apply to the Court for an adoption order. Otherwise, and also in the case of an adoption order being refused, the child returns to the care of the adoption society. Child protection visitors are required to visit and examine adopted children in their area. Advertisements regarding adoption by parents or guardians, or would-be adopters, or any persons other than a registered adoption society or a local authority, are forbidden under penalty.

Cruelty to Children. Under the Children and Young Persons Act cruelty, which includes neglect, to any child or young person under 16 by a person over 16 is punishable on conviction by imprisonment up to 2 years or a fine up to £100.

It is a penal offence for a person over 16, who is in charge of a child under 7, to allow the child to be in a room with an open fire-grate without sufficient protection against being burnt or scalded, so that the child is killed or suffers serious injury.

It is penal too under the Act to give intoxicating liquor to children under 5, to allow children to be in the bars of licensed premises, or to fail to provide for the safety of children at entertainments.

Employment of Children. Also under the Children and Young Persons Act no child may be employed under the age of 12: or before the close of school hours on a day when he is due to attend school: or for more than 2 hours on a day when he is due to attend school: or for more than 2 hours on a Sunday: or before 6 A.M. or after 8 P.M. on any day. And no child may be employed to lift or carry any weight which is beyond his strength.

Under the Education Act, 1944, if it appears to a local education authority that a child registered at a county, voluntary or special schoo is being employed in such a manner as to be prejudicial to his health or otherwise to prevent him from obtaining full benefit from the education provided, the authority may by notice in writing to the employer prohibit him from employing the child, or impose such restrictions upon his employment of the child as seem to them expedient in the child's interests.

The authority in such a case may by notice in writing require the parent or employer of the child to provide them with such information as will exhibit whether the child is being employed in such a manner as to prevent him from obtaining such full benefit.

Any person who employs a child in contravention of any prohibition or restriction as above, or who fails to comply with the request for information, is liable on summary conviction to a fine for the first offence up to £1, for a second offence up to £5, and for a third or subsequent offence up to £10 or a month's imprisonment or both fine and imprisonment.

Foster Children. Under the Public Health Act a person who undertakes for reward the care of a child under 9 apart from his parents or having no parents must give notice to the welfare authority in the case of the first such child not less than 7 days before he receives him, and in the case of each subsequent child not less than 48 hours before. He must give notice also if he changes his residence or if the foster child dies or is removed from his care. The welfare authority must ascertain whether there are any foster children in their area and, if so, must appoint one or more child protection visitors, usually health visitors for the area, whose duty it will be to visit the foster children in order to satisfy themselves as to their well-being and give requisite advice.

A foster child may not be kept without the consent of the welfare authority by persons convicted of certain offences or in dangerous or insanitary premises. If a foster child is kept or is about to be kept in dangerous or insanitary premises or by a person unfit to have the care of the child, a court of summary jurisdiction on the application of the welfare authority may make an order for the removal of the child to a 'place of safety.' In the case of the death of a foster child the person in charge must notify the coroner of the death within 24 hours of its occurrence.

No person who keeps a foster child may have any interest in the life of the child for life assurance purposes. It is an offence for any such person to insure or try to insure the life of the child, and for any company or person knowingly to issue or try to issue a policy on the child's life.

These provisions do not apply to relatives or legal guardians or to the care of mental defectives or to specified schools, hospitals and other institutions or organisations of good standing.

IV.

SCHOOL HYGIENE

Parents in Great Britain must procure education for their children of school age, and education authorities have a duty to provide suitable education for all normal children, as well as for abnormal children who can benefit by modified education. Elementary school children form about one-sixth, and school children in general close on one-fifth of the total population.

School medical inspection was first provided in England and Wales by the Education (Administrative Provisions) Act of 1907 and in Scotland by the Education (Scotland) Acts of 1908 and 1913. The report of the Interdepartmental Committee on Physical Deterioration published in 1904, together with the evidence of the low physical standard of army recruits during the Boer War, played an important part in establishing the school medical service. Later legislation from time to time has consolidated these provisions. The most recent statutes are the Education Act, 1944, and the Education (Scotland) Act, 1945. A reference to some of their contents will be appropriate here.

Education Act, 1944. This Act reforms the law relating to education in England and Wales. It establishes a Minister and a Ministry. The councils of counties and county boroughs are the local education authorities, or else there may be joint education boards. Each authority must appoint an education committee.

The grades of education are primary, secondary and further education. Provision is made for religious instruction. Ordinary schools are classed as county and voluntary. Of the last there are 3 varieties. There are also nursery schools, special and independent schools, and nursery classes.

'Compulsory school age' means any age from 5 years up to but excluding 15 years, so that a person who has attained the age of 15 years is over the compulsory school age. Under specified conditions it is permissible for the Minister to lay before Parliament a draft Order raising 15 years to 16. It is the duty of the parents of children of compulsory school age to secure their regular attendance at school.

'Further education' is provided for young persons over the compulsory school age but under 18. It will be conducted in 'county colleges' to be established within 3 years of the commencement of the Act. The courses will include such physical, practical and vocational training as will enable the young persons to develop their aptitudes and so prepare themselves for the responsibilities of citizenship.

The submission of certain pupils to medical inspection can now be requested under a penalty. Free medical treatment is made available to pupils attending any school or county college. Milk, meals and other refreshments are to be provided, under regulation, to the same recipients. Under specified conditions an issue of necessary clothing, including footwear, may be made to pupils attending schools. It is the duty of every education authority to ensure that the facilities for primary, secondary and further education include adequate arrangements for recreation and social and physical training.

Extensive powers with a view to the cleanliness of school children are conferred upon education authorities. The same authorities may prohibit or restrict the employment of children. No fees are permitted to be charged at any school maintained by an education authority or at any county school, but in certain cases, where board and lodging are being provided, fees may be payable according to a scale. Where it is necessary to facilitate the attendance of pupils at school, the education authority is required by the Act to make suitable arrangements for transport, or else to defray the travelling expenses of the pupil or pupils concerned.

Education (Scotland) Act, 1945.[1] This is an Act to amend the school medical services of Scotland, in its treatment of which it substantially resembles the English Act of 1944 as summarised above. Not being an Act for reform, it does not include any equivalent of what is said in the opening paragraph of the English summary, but the whole remainder of the summary, beginning with the 'grades of education,' applies to Scotland *mutatis mutandis* as closely as it does to England and Wales, and for the purposes of this section, subject to the following exceptions, it may be so read.

'School Age.' In Scotland up to 1st April, 1946, school age will mean any age from 5 years up to, but excluding, 14 years, so that any person who has attained the age of 14 years is over school age.

'Further Education.' County Colleges are in Scotland to be called 'Junior Colleges.'

'Cleanliness.' The fine attached to persistent uncleanliness runs higher in Scotland than in England.

'Employment of Children.' A parent or employer in Scotland who feels aggrieved may appeal to the Secretary of State.

School health measures, which are for practical purposes the same in both England and Scotland, will be considered under the following heads: (1) School Premises, (2) Medical Inspection, (3) Treatment, (4) Disability, (5) Infection and (6) Welfare.

SCHOOL PREMISES

The site of the school, unless in congested districts, should provide at least half an acre for every 200 scholars, with a minimum of four and a half acres for primary and nine acres for secondary schools. Nursery and infant schools require up to two and a half acres. It is best for a school not to be on a main street. It is good that it should be away from the dust and noise of traffic, and removed as far as possible from factory smoke and fume. It should, where possible, be near the local lending library, swimming bath and school clinic.

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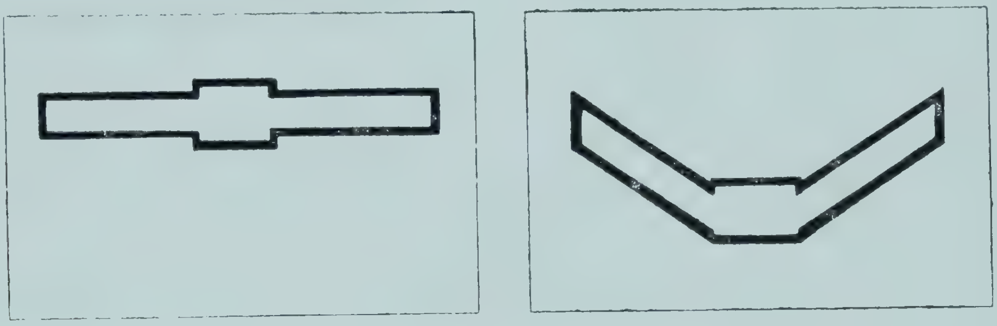
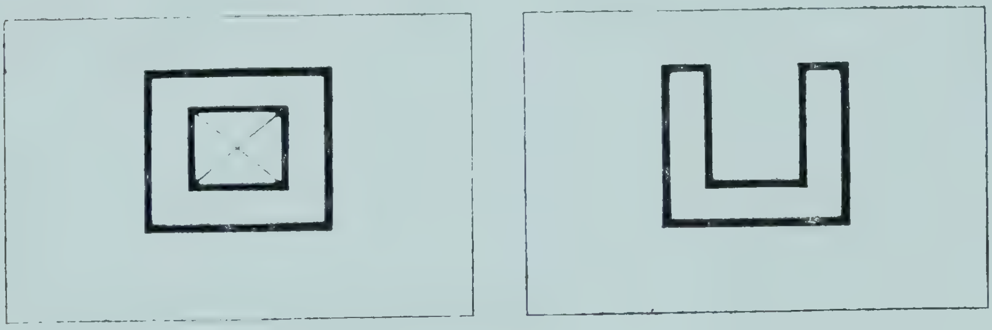
[1] See also page 690.

The primary need in school architecture is for educational convenience but due attention should be paid also to external form so that pleasing design and surroundings may develop a sense of pride in the pupils.

Playgrounds. There should, unless in congested districts, be 50 square feet of playground per scholar. Playgrounds should have a sunny exposure. Part of the ground should be finished with a hard dry surface, such as concrete, or green-tinted asphalt, for open-air physical training and organised games. Part should be covered with turf or cinders for rough-and-tumble play. Jet drinking-fountains with push-button control should be erected in the proportion of 1 per 100 scholars. There should be a suitable play-shed with seats, and hooded receptacles for waste paper. Bicycle lock-up racks should be provided.



PAVILION. BUTTERFLY.



CENTRAL HALL. OPEN SQUARE.

Fig. 12.—School Buildings Designs.

Where the playground adjoins a main thoroughfare break-run posts should be put at the gates. In the case of secondary schools, up to ten acres of suitable ground adjoining or near to the school should be acquired for playing fields.

School Buildings should comply with all proper structural requirements and should be so planned in all their parts as to admit of thorough and easy cleaning. Prevailing designs are shown in Fig. 12 and listed hereunder:

1. *Pavilion:* with central administrative block and a range of class rooms to right and left.
2. *Butterfly:* with central administrative block and the class rooms grouped in two or more angled wings.
3. *Central Hall:* with the class rooms enclosing a roofed-in hall.
4. *Open Square:* with the class rooms on three sides of an open-air plot.

Nos. 1, 2 and 4 are better than No. 3. No. 1 is most often a ground floor building. Nos. 2 and 4 have usually storeys added. All should be arranged to admit direct sunshine, and the class rooms, which should

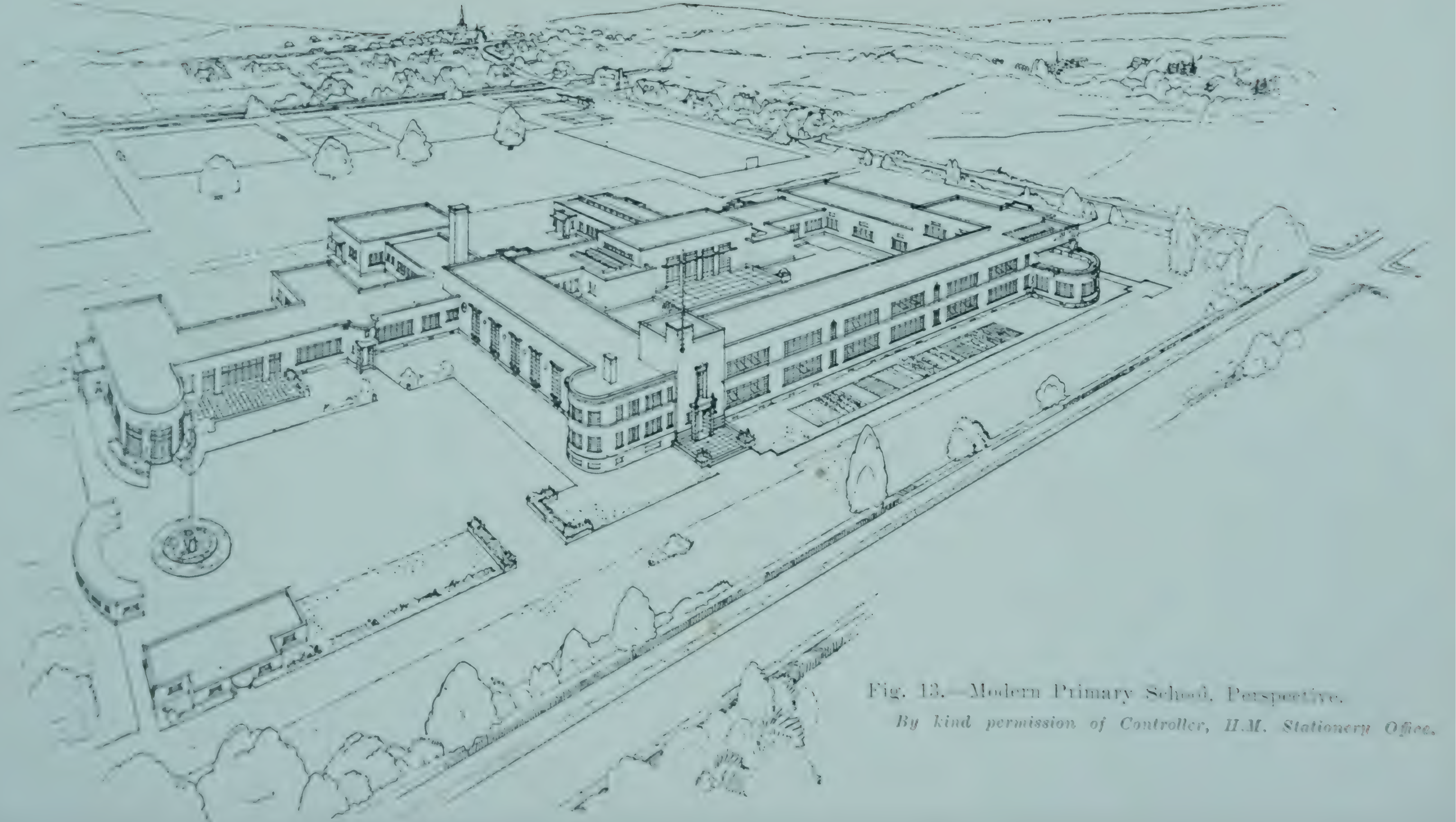


Fig. 13.—Modern Primary School, Perspective.

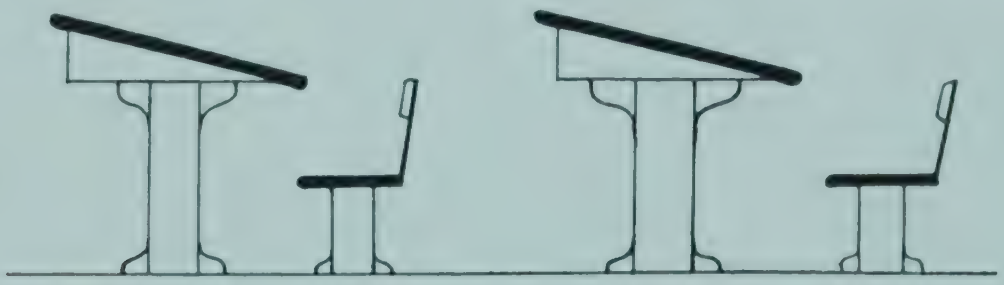
By kind permission of Controller, H.M. Stationery Office.

have a south-east exposure, fitted with folding sides opening on verandahs. All may be cross-ventilated, the Hinckes-Bird device being a useful adjunct. All types may be built with two storeys. No. 3 requires artificial ventilation. The noise of games or drill in progress in its central hall is apt to distract the children in the surrounding class rooms. Owing to its compact arrangement it has been found appropriate for congested areas.

Reinforced concrete and steel now play an increasingly important part in the construction of school buildings. With a view to hastening the completion of post-war schools the standardisation of beams, stanchions and roof trusses and the pre-fabrication of doors, window-frames and panels have been suggested.

The School Buildings Committee of the Board of Education have proposed in a recent report that the school of the future should consist of an assembly of standard units, connected or free, arranged with respect to one another in the most convenient manner. Such standard units would provide a ready means for adding to existing schools which required expansion.

Class Rooms. The normal floor space for class rooms should be 16 square feet per scholar. In elementary schools not more than 40 scholars should be accommodated in a class room: in secondary schools not more than 30. Walls should be lined up to 4 feet with varnished wood surmounted by cheerful paint-work which does not tax the eye. Educational friezes are a suitable decoration for junior class rooms. The height of the ceiling should not exceed 12 feet. Light should come from the left-hand side of the scholars. The windows should measure one-fifth of the floor space, and should be fitted with sun blinds. Artificial lighting should be shadow-free. When electric it is best provided either by opal bulbs or fluorescent tubes. No luminous part of a light fitting should be less than 9 feet above floor level. No fitting should distract the pupils' attention. Rooms should wherever possible be sound-proof. Blackboards should not be more than 25 or less than 7 feet distant from any scholar. They should be constructed of slate or matt surface wood and may be electrically flood-lit. Yellow boards for blue chalk writing have been recommended. Writing surfaces of flexible fabric which move on the endless belt principle are now in use in schools. To protect the children from eye strain occasioned by having to keep looking up, there should be no teacher's platform. Books should be printed on matt-surfaced, opacified paper and the type should be clear. For elementary classes, Pica or 12 point type is recommended. Small Pica or 11 point is permissible for senior children. In kindergarten books, 'English' or 14 point characters should be employed. The lines of print should in all cases be spaced by 1 point leading. Not more than two lines of print should be visible when viewed through an aperture of 1 cm. square. This is known as Cohn's Test. Italics and decorative capitals should be avoided in the composition of children's books. For desks the fixed dual pattern is usual. Infants require low moveable tables with individual chairs. No desk should be more than 20 feet from a window. Between desk and desk and between desk and wall there should be a clear gangway 18 inches broad. Desk tops should have a slope of 8 degrees, should be adjustable to a horizontal position with the minimum of noise, and should have a light, matt finish. When the edge of the writing surface overhangs the fixed seat, best by 1 inch, it is a *minus* desk: when there is no overhang it is a *plus* desk. The *minus* desk, which encourages correct posture, is the pattern of election. The best results in warming class rooms have been obtained from full-power low-pressure hot-water central heating, either by means of radiators or on the panel system, with thermostatic control. Electric heating may also be employed either on the indirect plan, by which the current is utilised to heat water in radiators, or directly, by tubular heaters. Temperature, as shown by a thermometer hung in every class room, should range between 60° and 65° F. One room should be adapted for cinematograph projection and furnished with a screen to take a picture not less than four feet by three. A small emergency room should be situated on the ground floor and equipped with hot and cold running water, couch, first-aid box and means of warming. New schools should be wired for broadcast reception. Rooms in existing schools may require acoustic treatment in order to ensure satisfactory reproduction of the programmes. Loud speakers should be centrally placed, facing the pupils, and should not be more than 6 feet above floor level.



Minus *Plus*

Fig. 14.—Desks.

Staircases should be 4 feet 6 inches in width and should be fire-resisting. Flights should be short and straight and well-lit and there should be no steps on landings. Treads should not be less than 12 inches broad and risers not more than 6 inches high. A non-slip surface is advantageous. For floors, if any, above the ground floor an external all-metal staircase should be added for escape in the case of fire. Corridors should not be less than 7 feet wide. Their surfaces, best of terazzo, should be deadened to minimise noise.

Ablution. Wash-hand basins with both hot and cold water should be in the proportion of 1 to 10 scholars. Soap, whether solid or liquid, should be bland and unmedicated. Roller towels should be frequently changed, or good quality crêpe paper towels supplied. Hot-air driers for the hands have been suggested. Spray- or shower-baths, where provided, should suffice to bathe 12 to 20 children at once, and there should be accommodation for dressing, and for drying and storing towels. A swimming bath, if attached to the school, should be managed *mutatis* *mutandis* as noted below.[1] At the deep end the depth of water should not exceed 4 feet: at the shallow end it should not be more than 2 feet. For children the water temperature should be between 65° and 70° F., and they should not be allowed to stay in the bath for more than 20 minutes. Each dressing cubicle should be made to accommodate two children and should be centrally heated by means of low-pressure hot water. Wherever practicable, the bath water should be recirculated and, if chlorine is the disinfecting agent, dosed with chlorine gas by means of a pulsometer or similar device. In the case of smaller baths, where bleaching powder or a hypochlorite may have to be used, every precaution should be taken to avoid over-dosage. Concentrations which would merely cause the eyes of adults to smart may be provocative of disease in the more sensitive eyes of children.

Cloak Rooms in schools should be separate from class rooms and passages. Their thorough ventilation and warming are essential. Hat pegs, preferably numbered, should be set 12 inches apart for girls and 6 inches for boys. Special arrangements should be made for drying wet clothes, and shoe cages should be provided. Main latrines should be placed outside the school building, and will nowadays with few exceptions be on the water-carriage system. A few emergency lavatories should also be located at convenient points within the school. Twenty linear feet of urinal are required for every 100 boys. The w.c. accommodation should be 1 fixture for every 10 infants, 1 for every 25 boys and 2 for every 25 girls. All fixtures should be thoroughly up to date from the sanitary point of view, and adjusted in their height to suit infants and two or more groups of older children. Each fixture should be in a separate compartment provided with a simple bolt which can in emergency be withdrawn from the outside by the janitor. All urinals, fixtures and the latrine premises generally should be regularly and thoroughly cleansed. It should not be necessary under ordinary circumstances to apply disinfectants. For country schools without water carriage the chemical privy will be found convenient, or alternatively the automatic earth pail system may be employed.

In residential schools sanitary fixtures should be provided in the proportion of 1 w.c. for every 5 girls and 1 for every 10 boys.

In primary, secondary and advanced division schools a gymnasium should be provided. It should be not less than 60 feet by 30 feet in dimension and be fitted with simple appliances only. Separate dressing rooms are required for boys and girls, and at least ten showers should be installed. The woodwork, cookery and other technical instruction premises should be apart from the main school building: an assembly hall with stage equipment may be included.

MEDICAL INSPECTION

It is the duty of all local education authorities to provide for the medical inspection, at appropriate intervals, of pupils attending any school or county college maintained by them, and it is in their power to initiate a similar inspection for senior pupils attending other educational establishments.

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[1] Page 340.

The education authority may also, through one of their officers, require the parent of any school child to submit the child for medical inspection as provided by the authority. In the case of a county college or other educational establishment they may make a similar demand of the pupil concerned. There is a fine on summary conviction for non-compliance.

MEDICAL RECORD CARD

1. NAME
    Address
2. PERSONAL HISTORY:
    Previous Illnesses of Child
    Family Medical History
3. PRESENT CONDITION:
    Date of Inspection
    Standard and Regularity of Attendance
    Age of Child
    Height
    Weight
    Clothing and Footgear
    Cleanliness and Condition of Skin
        Head Body
    Nutrition
    Mouth and Teeth
    Naso-pharynx
        Nose Throat Glands
    Eyes
        External Disease
        Visual Acuity (Snellen)
            R L
    Ears
        Diseases
        Defective Hearing
    Speech
        Defective Articulation
        Stammering
    Mental and Nervous Condition
        Backward
        Dull
        Mentally Defective
        Highly Nervous
        Difficult in Behaviour
    Circulatory System
        Organic Heart Disease
        Functional Conditions
    Lungs
        Chronic Bronchitis
        Suspected Tuberculosis
        Other Diseases
    Deformities
    Infectious Diseases
    Other Diseases or Defects

4. VOCATIONAL GUIDANCE

To be completed at final examination before child leaves school and revised in the light of re-inspections and special examinations.

Child unsuitable for:

- Severe manual work.
- Sedentary occupation.
- Exposure to bad weather.
- Work in a dusty or damp atmosphere.
- Work near moving machinery or moving vehicles.
- Work involving prolonged standing: much walking: quick movement from place to place.
- Work causing eye-strain.
- Work requiring acute distance vision.
- Work requiring acute hearing.
- Occupations requiring manipulative skill.
- Certain occupations on account of defective colour vision.

It is usual for school children to undergo three medical inspections in the course of their school career. The routine procedure is that the School Medical Officer advises the Head Teacher that he proposes to inspect a particular group, say an age group, on a specified date. The Head Teacher by means of the appropriate form, which is given to each child to take home, asks the parent or guardian to indicate whether he is willing or unwilling that the child should be inspected, and invites him to be present. If the parent expresses himself as unwilling, or fails to return the form, it will be open to the education authority to take the action mentioned in the preceding paragraph. From the forms bearing the parental consent, when brought back by the children, the Head Teacher fills in for each child due for examination I his Medical Record Card[1] up to and including the item 'Age of Child.' In the subsequent use of the medical record card for examinations II and III these particulars are already entered. Next the school nurse visits the school. She weighs and measures the children, observing the state of their clothing and footgear and their general cleanliness. She tests vision with Snellen's types, except children under 6. She enters up her findings on the medical record card. Finally the school medical officer makes his inspection, the school nurse and frequently the child's parent or guardian being present. Having noted the school nurse's entries he completes the medical examination, devoting specially careful attention to children under weight or otherwise subnormal. He advises the parent, if present, verbally: if not present, by means of an advice note to be taken home by the child. In either event it is the duty of the school nurse to keep in touch with the case and report in due course as to the steps, if any, taken to comply with the advice offered.

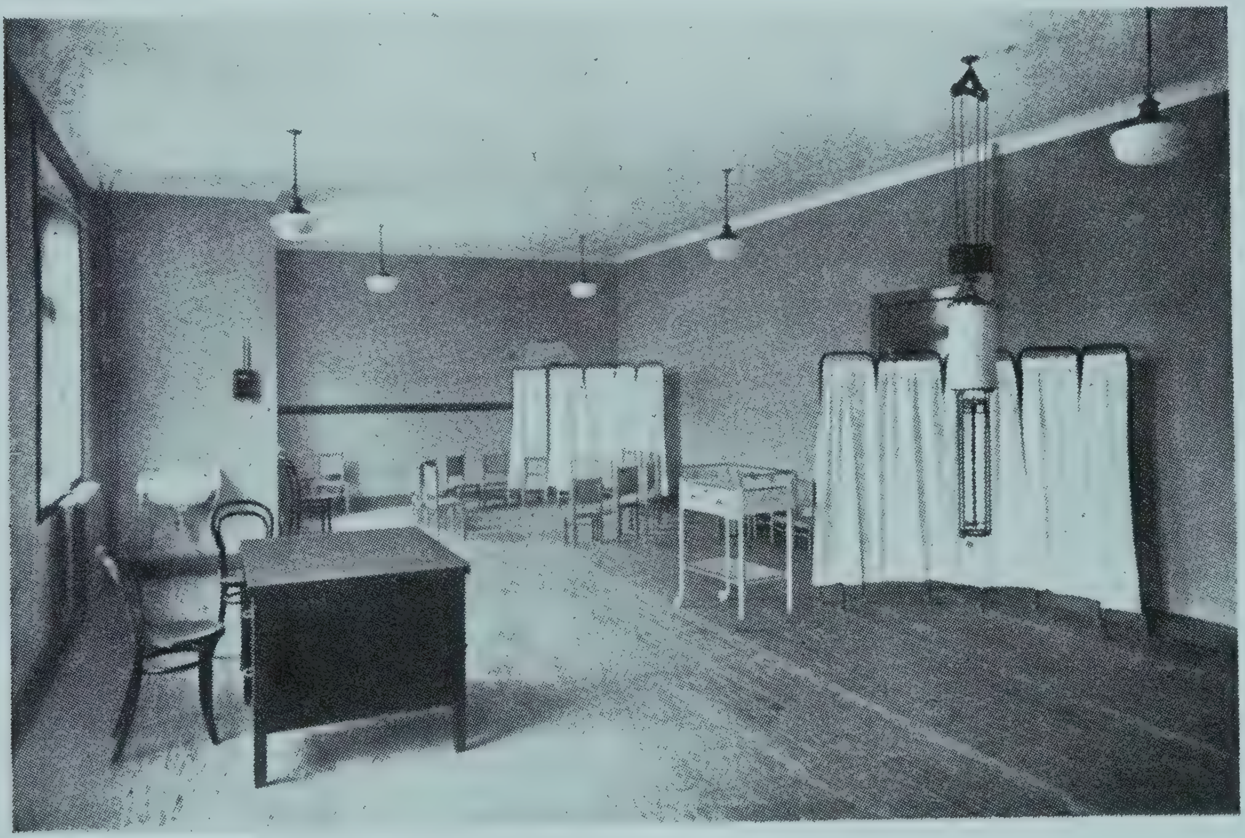

Fig. 15.—Actinotherapy Room.

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[1] Page 50.

TECHNOLOGICAL RESEAR

The school medical officer on the occasion of a routine medical inspection should examine also special cases presented to him by head teachers on account of nervous symptoms, otorrhoea, mouth breathing, dermatosis or other abnormal conditions which may have come under notice. He may be required also to inspect the whole school premises and to report thereafter upon their sanitary state to the medical officer of health. Other duties which may be assigned to the school medical officer include decisions as to school closure and exclusion from school, assistance in the preparation of courses in personal hygiene and physical training and duties connected with mentally and physically defective children.

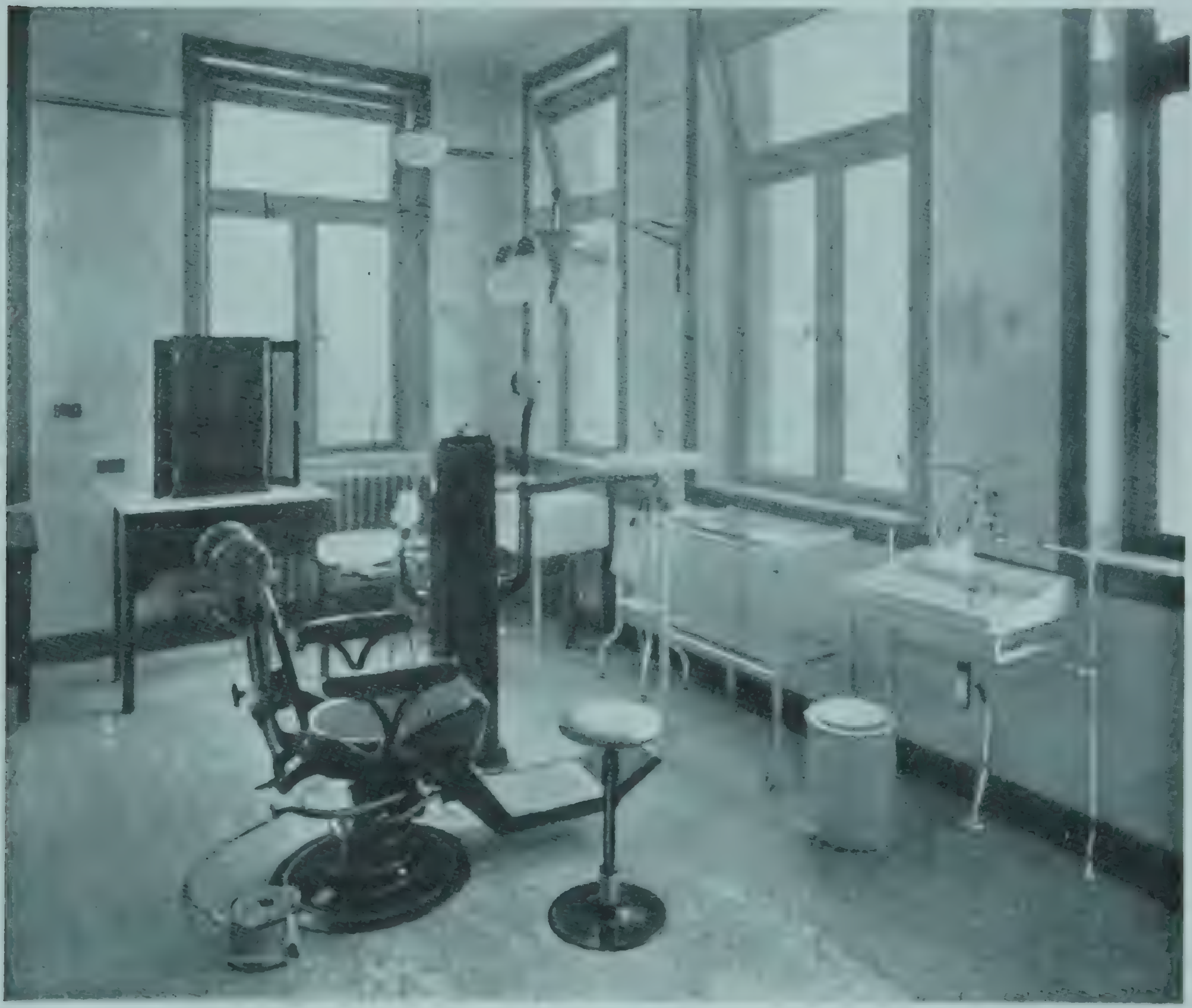

Fig. 16.—Dental Clinic.

TREATMENT

Comprehensive facilities for free medical treatment must now be provided by all local education authorities for pupils attending any school or county college maintained by them. These facilities may be either under the Education Act, 1944, or otherwise, and authorities may extend them to include senior pupils at other educational establishments than those above specified. Authorities may encourage and assist pupils to use the services thus made available, unless a parent or guardian objects, when no further action will be taken.

Free medical treatment, unless in exceptional cases, does not include treatment in the pupil's home.

Of the disease conditions found at medical inspections to require treatment the most prevalent is dental caries. Next in order come enlarged tonsils with adenoids, enlarged lymphatic glands and visual defects. Less frequent but still of constant occurrence are blepharitis, strabismus, malnutrition, cardiac dysfunction, rickets and parasitic invasions. A certain number of such cases will be referred to the family doctor for treatment, either conducted by himself or arranged for with a specialist. The majority will usually be referred in the first instance to the school clinic. In some areas all general and specialised out-patient treatment may be given at a central polyclinic which is visited by orthopaedic surgeons, oculists, aurists, dermatologists, dental surgeons and radiologists retained by the local education authority. In smaller areas the functions of the school clinic may be limited to minor services, while for specialist treatment the children are passed by arrangement to a specialist clinic of the education authority or to the out-patient department of a voluntary hospital. Some cases may proceed direct to hospital wards.

Among services commonly rendered by school clinics are included the distribution of cod-liver oil and malt to debilitated children, the supply of milk and other nutritious substances to children convalescent from illness, actinotherapy (Fig. 15), dental treatment (Fig. 16), the dressing and repair of minor injuries, the treatment of scabies, impetigo and ringworm, and the issue of lines of admission to holiday homes in the country or by the sea. Refraction and the orthoptic treatment of squint may also be undertaken. The school clinic may be used also for the certification of children as to their fitness or unfitness to attend school. Medical treatment being now free, the cost of treatment or a portion of it is no longer recoverable from the parent or guardian.

If the school medical service is to succeed in its preventive aims, the constant co-operation of parents and teachers is required in order to ensure that all treatment prescribed by the school medical officer is carried out, particularly with regard to aural, ocular and dental defects.

DISABILITY

Among the forms of disability affecting school children for which appropriate arrangements require to be made are retardation, mental deficiency, blindness, deafness, epilepsy and physical crippling.

Retardation is here intended to include ‘dullness’ in which there is inborn mental impairment but not mental deficiency, and ‘backwardness’ in which progress in school has been slowed down by such agencies as inefficient teaching at early stages, physical defect, temperamental abnormality, illness or interrupted attendance. Most dull and backward children may properly attend a public elementary school, though special classes may be advisable for some.

Blindness. The duty of a parent to provide education for his children includes that of causing a blind child aged 5 to 16 years to receive suitable instruction. If suitable means are not otherwise available it is the duty of the local education authority to make provision in a school certified by the Board of Education as suitable. A blind child is one too blind to read the ordinary school-books used by children. Children with visual acuity 6/24 or so after correction, are regarded as partially sighted. Their number has been estimated at 1 per 1000 of the elementary school population. They are provided for in special classes at ordinary schools with near blackboards, books with 18 point type and other devices. Children suffering from progressive myopia attend myope schools, where in hopeful cases every effort is made by the use of modern blind-teaching methods, frequent refraction tests and appropriate change of glasses to conserve their imperilled vision. Other myopes who are destined to lose all power of seeing are taught in advance to read and write Braille (Fig. 17) and trained in massage, piano tuning or other vocation suited to the totally blind. It is the duty of the education authority to provide partially sighted children with both conveyances and guides between their homes and the school. For the totally blind children residential institutions

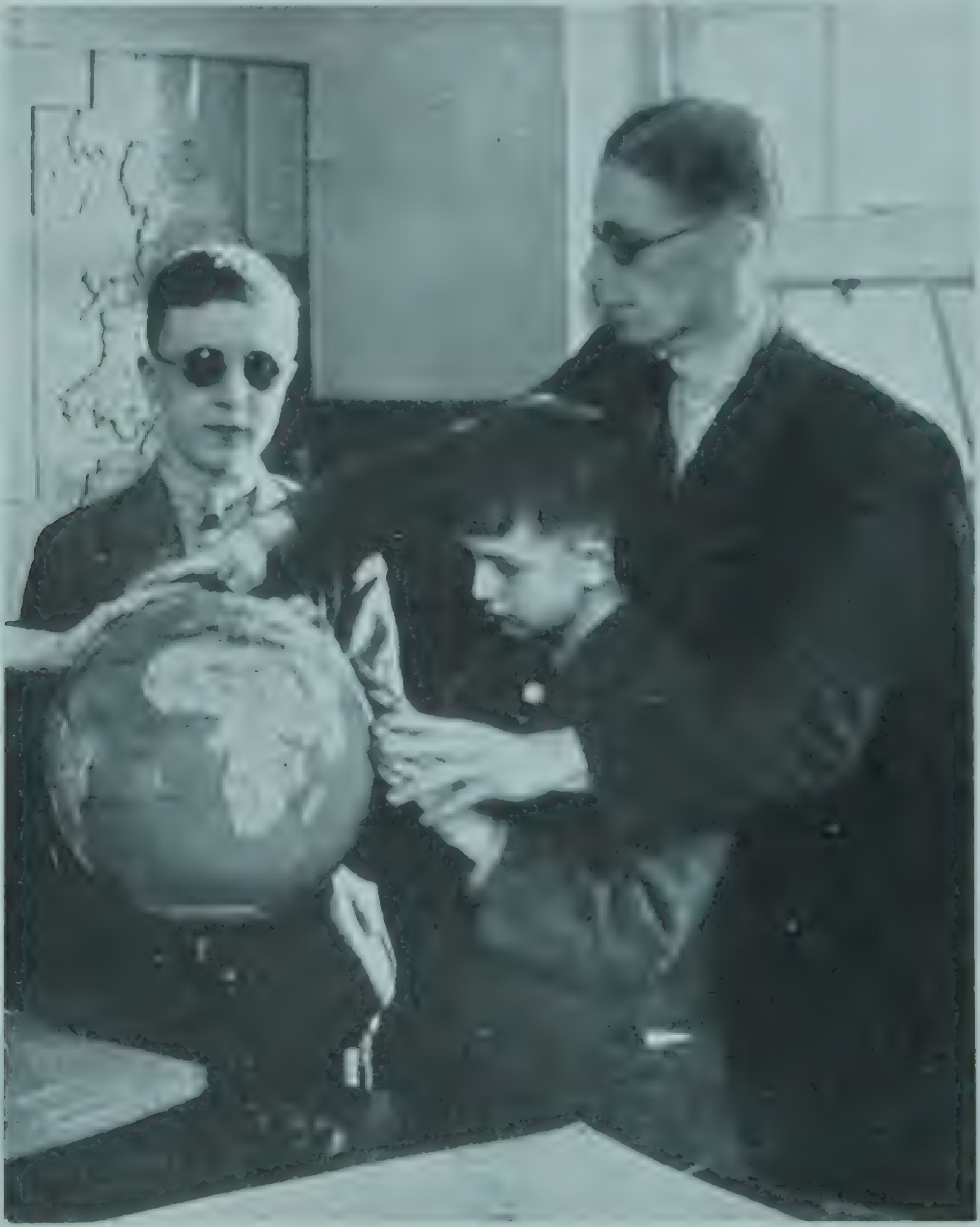

Fig. 17.—Teaching geography to blind boys by a modification of the Braille system.

are in general to be recommended. The Board of Education assists local authorities by making *per capita* grants in respect of the children placed in such institutions.

Deafness. For deaf children aged 5 to 16 years the duties of the parent and the education authority correspond to those for blind children. A deaf child is one too deaf to be taught in a class of hearing children in an elementary school. A recent survey has shown that 30 per cent. of school deafness is congenital and 70 per cent. acquired. Among the remediable causes of acquired deafness are eustachian catarrh, otitis media, measles and scarlet fever. Routine testing of children's hearing may be carried out by means of the gramophone audiometer which speaks a series of double- or treble-digit numbers in varying grades of intensity. Twenty children can be tested at one time. For the analysis of auditory acuity the electrical 'pure tone' audiometer is required. It determines, at each pitch, the faintest sound which the test subject can hear. It indicates both the hearing loss and the nature and situation of the defect. Deaf children described as hard of hearing are those who can hear the forced whisper with at least one ear at 3 feet but not at 6. They may be sent to special classes at the ordinary schools. Deaf mutes and other totally deaf children should be dealt with in special schools, preferably residential. Lip reading forms the basis of their instruction (Fig. 18), aided by pictures and models, sound amplifiers with headphones, and instructional sound films. The finger alphabet may form part of the curriculum. Most of the children pick it up outside, as it is still the staple means of communication among the adult deaf. In cases where total deafness has existed from infancy, steps are taken with the

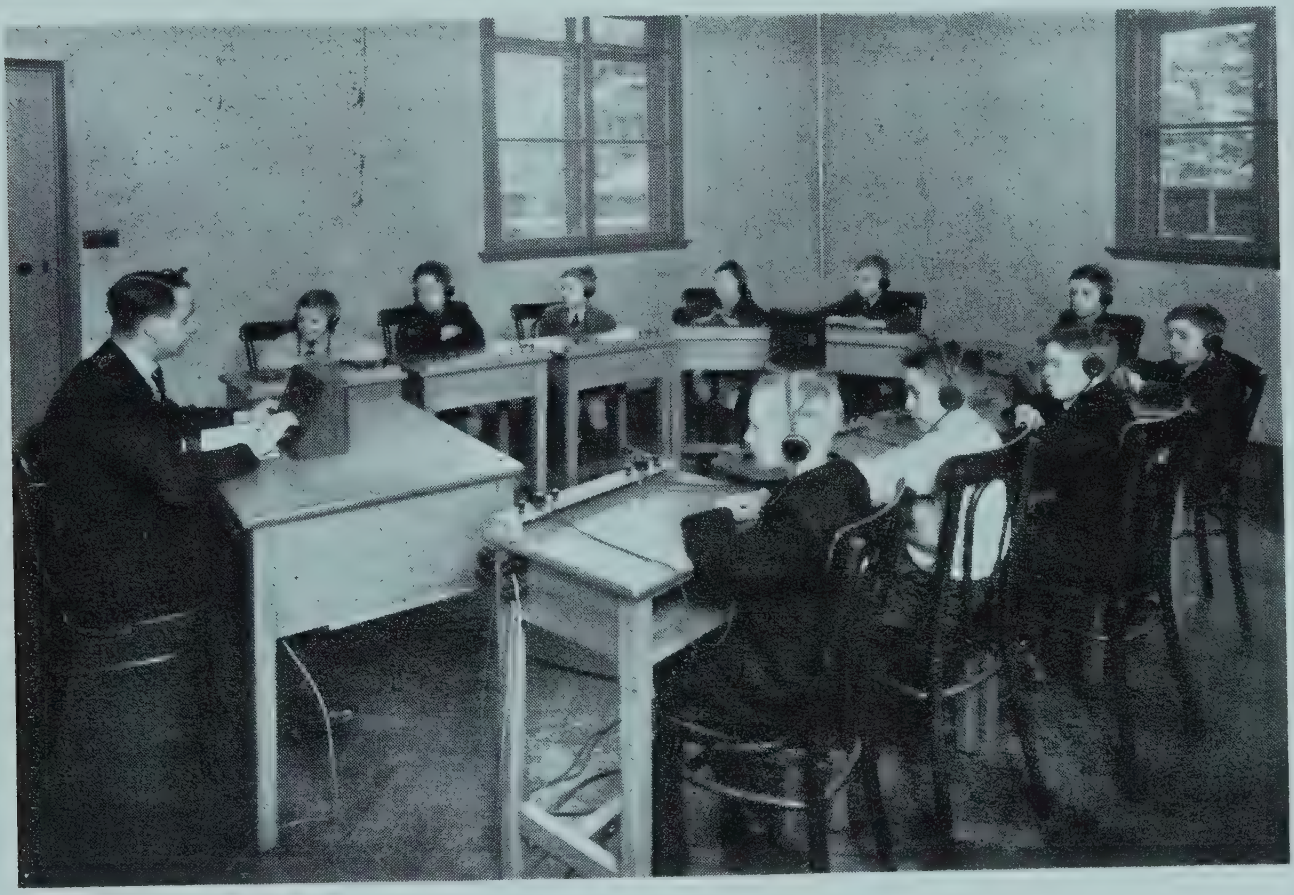

Fig. 18.—Lip Reading.

object of developing a normal speaking voice. Deaf schools are often associated with defective speech schools and classes for stammerers. It has been suggested that a national scheme for the deaf comparable with that for the blind is required for the solution of the deafness problem. Much good work in this direction has already been done by the National Institute for the Deaf and National College of Teachers of the Deaf.

Speech Defect. Educationists have found this condition to affect from 3 to 6 per cent. of the school population. The deficiency may be dysarthria, most commonly stammering, in which there is a mechanical difficulty of articulation, or aphasia, in which there is an accompanying intellectual defect with normal articulation. The physical causes of stammering include deafness, cleft palate, malformation of the tongue, pyramidal or cerebellar disease and certain neuropathies. It is now the custom of speech therapists to reserve the term stuttering for an inhibition of the normal flow of utterance in the absence of physical defect. It is generally due to emotional imbalance, though a few cases have an imitative basis. Aphasia is usually the sequel to a lesion of the *cortex cerebri* and may be either stationary or progressive. In the motor form of the syndrome the patient loses the power of thought expression. Sensory aphasia has aptly been termed word blindness and word deafness, the visual and auditory impressions having lost their symbolic value. The patient's speech may in consequence be unintelligible jargon. Remedial instruction for dysarthria is usually given in part-time classes by specially trained teachers and includes breathing exercises, relaxation periods (Fig. 19), rhythmic speech training and singing. When the co-operation of patient and parents is satisfactory it is possible to effect a cure in 50 per cent. of the cases.

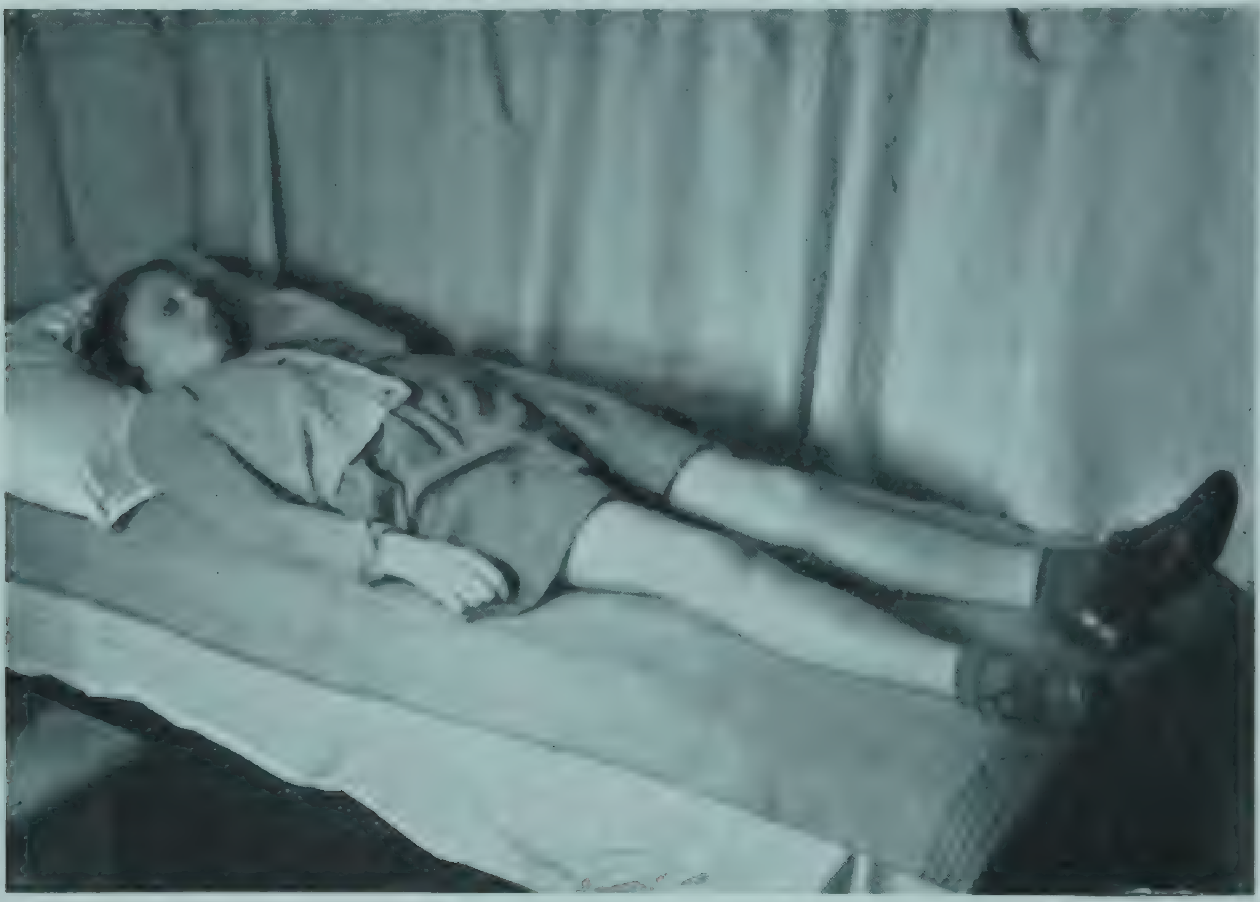

Fig. 19.—Relaxation therapy for stammering.

Epilepsy. Epileptic children in the statutory sense are those who, not being idiots or imbeciles, are unfit by reason of severe epilepsy to attend the ordinary public elementary schools. They should be educated in residential schools. It is the duty of the parent of an epileptic child aged 7 to 16 years to cause him to attend any class or school certified for epileptics. Slight epilepsy, *petit mal* or pyknolepsy need not disqualify from attendance at an ordinary school. Epileptics who are also mentally deficient should be segregated in colonies where they may engage in handcrafts.

Physical Crippling. The chief sources of physical crippling among school children are congenital deformity, non-pulmonary tuberculosis, rickets and the sequelae of poliomyelitis. The treatment and education of the cripple child must be carried on side by side. Arrangements to meet this requirement are made by means of hospital and sanatorium schools: open-air schools, day or residential: and cripple schools, day or residential. In sanatorium schools the hours of teaching should not exceed 3 per day. In cripple schools special care is taken that the desks and seats are adjustable to ensure the comfort of each child according to his infirmity. A fully trained nurse should be in attendance during school hours to supervise the splints and other appliances worn by the scholars and to deal with minor injuries. Other services include orthopaedic and after-cure clinics and physio-therapeutic institutes (Fig. 20) under the charge of qualified instructors and medical gymnasts. For physical crippling without deformity, as in heart disease resulting from rheumatism either declared or latent, sanatorium or other special schools may be provided.

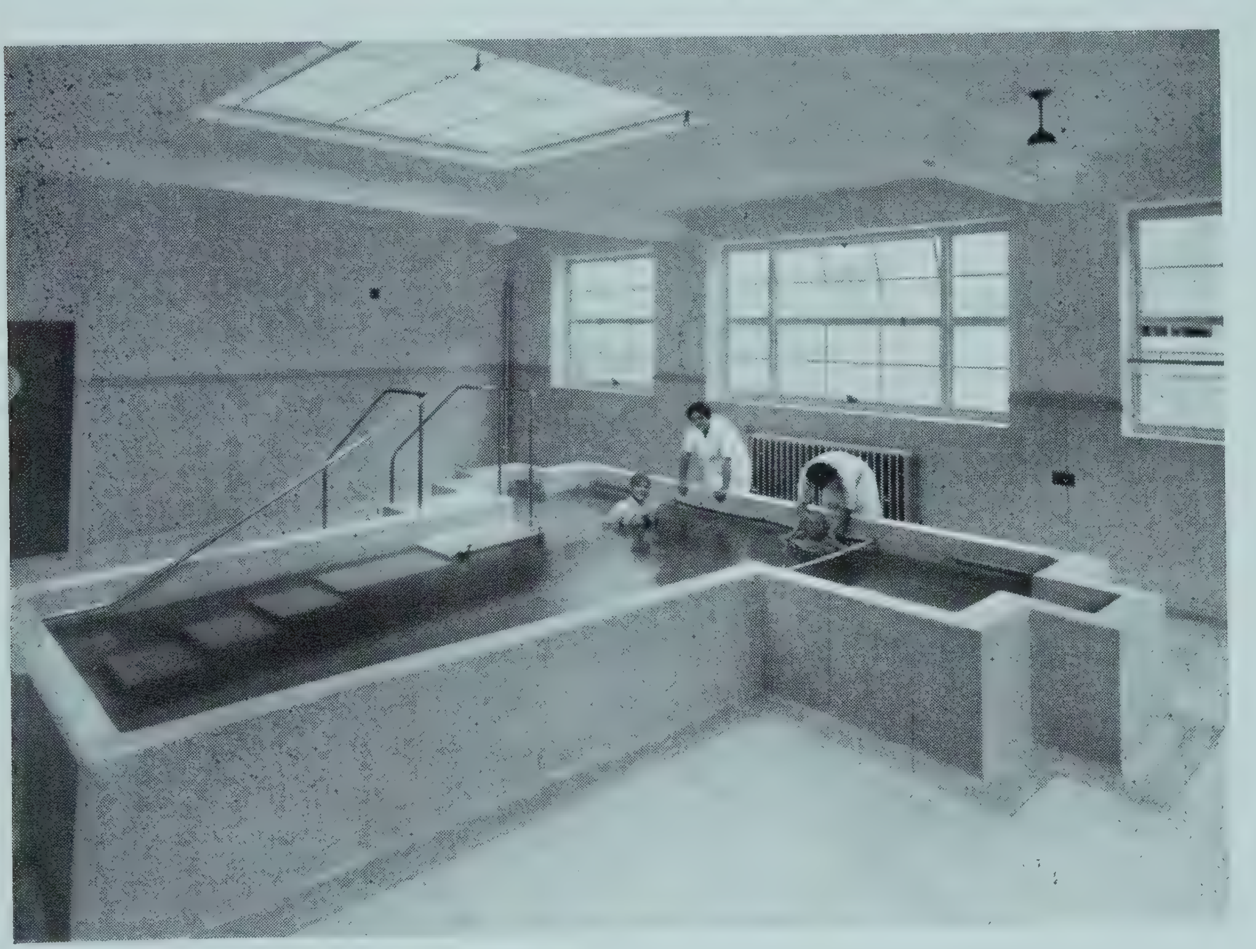

Fig. 20.—Remedial swimming bath for orthopaedic cases.

Physical defects which are remediable in the medical gymnasium include flat foot, mild kyphosis, knock knee and adenoidal breathing.

INFECTION

Action for the control of infectious disease figures prominently in school administration on account of the general susceptibility to infection in children of school age. A number of those living in crowded quarters may before entering school have already had attacks or have acquired a degree of immunity as a result of sub-infective inoculation.[1] In the case of children in better circumstances, however, the protection derived from such experiences may be lacking, and the risk of the spread of school infection among them is proportionately greater. Some cases are diagnosed at home, a doctor having been called in: others attract the attention of teachers in school and are sent home on suspicion. Teachers should be made acquainted with the signs of onset of the common infections of childhood and the sequelae which may develop in missed cases.

Control. When a case of infection occurs the school medical officer should examine all the children in the class. He may find other cases in early stages, or possibly bring to light the missed case which originated the infection. In diphtheria and scarlet fever it may be appropriate to institute a search for carriers. The repeated rapid inspection of whole schools during a period of epidemic prevalence may be found useful.

The minimum period for the exclusion of infectious cases from school is the same as the isolation period noted in Table 36.[2]

The procedure in the case of children found verminous in school is stated under Infestation below.

School Closure. If adequate use is made of the method of excluding individual infective children, accompanied by a diligent search for foci of infection within and outside of the school, it should only in quite exceptional cases be necessary to close a school in the interests of public health. Among the few conditions under which the spread of a disease might conceivably be checked by closure would be that of a sparsely peopled district where the school was attended by a handful of children drawn from separate villages, in one of which an infectious disease was rife, while the others were free.

School Disinfection. As ringworm and pediculosis may pass from child to child by exchange of head gear, numbered and adequately spaced cloak-room pegs have a preventive value. As diphtheria has been conveyed by pen-holders and pencils, these articles should not be used in common. As most of the infectious diseases of children are spray-borne, a constant supply of fresh air should be maintained throughout all parts of the school building. Dust in the air of class rooms irritates the respiratory tract, which in this state is more prone to invasion by spray-borne organisms. Desks should be wiped over with paraffin-sprinkled dusters, walls damp-dusted and floors strewn with chemically treated sawdust to lay the dust before sweeping. The use of aerosols[1] in classrooms when respiratory infections are prevalent is worthy of trial. When cases of an infection such as scarlet fever are numerous, it is advisable to close the classrooms affected and treat their floors and furniture with a fluid disinfectant, preferably of the cresol type.

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[1] Page 403.

[2] Page 423.

WELFARE

The welfare activities of education authorities are mainly directed towards promoting healthy growth and development and instilling the principles of health. As the end of the school career approaches such activities may extend to the guidance of the child in the choice of a vocation.

Physical Training may take the form of approved exercises and games, conducted as far as possible in the open air, under the direction of expert and duly qualified instructors, men for the boys and women for the girls. Gymnastic costume of singlet or blouse, shorts and plimsolls should be worn by both sexes for games and exercises. At the end of the lesson each child should take a shower followed by a brisk rub down. A gymnasium or other large room should be available for use in wet weather and should contain a piano. It should be provided also with an ample supply of coir mats, agility mattresses, skipping ropes, balls and dumb-bells. The rhythmic movement type of exercise on the Swedish Ling system is now preferred to physical jerks. The vaulting horse, beam and climbing ropes are enjoyed by the older pupils. Team games too are of value, such as football and cricket for boys, and lacrosse and hockey for girls. Basket ball, volley ball, Rugby touch, tennis and folk dancing are available for either sex. Instruction in swimming should be provided, and children should be encouraged to qualify for the junior awards of the Royal Life Saving Society. Choral singing interests young children and is beneficial also as a breathing exercise. A number of schools conduct scout troops or companies of girl guides. Before taking part in physical training children should be passed by the school medical officer, special attention being devoted to rheumatic, nervous and similar cases. There is no need to forego moderate physical training during the menstrual cycle in adolescence. It should be made clear to schoolgirls that menstruation is not an illness. The daily routine of warm bath, gentle exercise and free action of the bowel should continue during the menstrual period. Alcohol in any form is contra-indicated.

Health Teaching. Every reasonable care should be taken in schools to bring up the children in habits of cleanliness and neatness. For younger children the instruction given should be practical, serving as an introduction to ways of healthy living. They should be required to show clean teeth and a clean face and hands, familiarised with the feel of fresh air in the class rooms, exercised in right breathing and right postures in standing, walking and sitting. Older children should be made aware of the reasons underlying these routine practices, and so led on to some appreciation of the principles of biology as applied to health. Good habits in this way become deeply rooted and last a lifetime. It is probably not too much to say that the correct teaching of hygiene in schools is the most effective method of health propaganda. The preparation of a comprehensive scheme of health teaching in schools is now engaging the attention of the Scottish Council for Health Education.[1]

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[1] Page 434.

Sex Teaching. The teaching of sex to children is properly a parental duty but many parents are reluctant to impart the knowledge, or are in need of guidance in the method of presentation. As a result, teachers feel an increasing responsibility to ensure that all children shall receive some form of sex instruction before leaving school. In so far as elementary schools are concerned, it is generally agreed that the lessons should begin with the rudiments of physiology and hygiene, the sex function being considered in its relationship to the organism as a whole. Simple biology, including the reproduction of small mammals, may be taught and illustrated by allowing the children to keep livestock. Educationists consider it important to introduce sex teaching at an early age before strong emotional associations develop. In secondary schools the instruction should be more advanced and should deal in a frank and simple manner with the main facts of human reproduction, including the pubertal changes, the need for continence, and the dangers of venereal disease. Senior girls may be taught mothercraft and pay visits to the local infant consultation clinic. The instruction of secondary scholars is best undertaken by the teacher, who should have undergone a course of study for the purpose, but may be supplemented by visiting lecturers such as those of the Central and Scottish Councils for Health Education and by the radio talks of the British Broadcasting Corporation. Arrangements may also be made for the loan of suitable books to pupils. Leaders of youth organisations, after appropriate training, may institute group discussions on social hygiene among their members, and deal with questions arising. The Board of Education have recently offered assurance of their warm support and encouragement to all teachers in schools, leaders of youth movements and members of local authorities who are devoting serious attention to the sex instruction of children and young persons.

HOME INFLUENCE

Much can be done by parents to inculcate the principles of personal hygiene in the young. A daily tepid bath at a temperature of, say, 90° F. should be encouraged. The swimming bath is popular with children but they should not be allowed to enter it within two hours of a meal, or to stay longer than twenty minutes in the water. Those who have a cardiac disability should not bathe without medical advice and any with tympanic perforations should wear ear plugs when swimming. Children should be taught that regular changes of underwear are a *sine qua non* of personal cleanliness. As parents decide on questions of clothing, footgear, rest and sleep, their views on such matters may determine the state of their children's health.

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[1] Page 590.

The broad principles of clothing are discussed under Personal Hygiene.[1] Subject to what is said therein, the following criteria should be adopted in planning the school child's outfit. They have reference to normal healthy children and should not be taken as applicable to those who suffer from a rheumatic or other specific lesion.

The clothing should be scanty. It should consist of the smallest number of garments compatible with warmth. The practice of hardening children by exposing them purposefully to the rigours of the weather is, however, not without danger. The attire should be evenly distributed over the body both back and front. In general an outer garment should be removed when the body is over hot and replaced as required. Underclothing should remain relatively constant in weight throughout the year. The feelings of the child on matters of warmth may within reasonable limits be relied upon. The weight of clothing worn should be determined by the prevailing weather and not by the calendar.

The clothing should be loose. The child's peripheral circulation is readily impeded by constriction, especially of limbs. Tight garters should be avoided and the leg elastics of knickers should be loose or, better, dispensed with. Continued localised pressure on the lower limbs may in time lead to chilblains which, from their pain and itching, occasion loss of sleep as well as inattention in school. Neither belts nor the waistbands of trousers or skirts should constrict. Where a heavy garment such as the kilt is worn, it should be suspended by buckles and straps fastening at the side so as to give a broad, wrapping effect. The view that girls approaching puberty require abdominal support is incorrect, and the use of rubber corsets or bands for this purpose is to be deprecated. Stocking suspenders should be attached to a bodice or in older girls to a light belt. They should not be adjusted to exert too strong a vertical pull and so cause dragging at the waist, discomfort and even pelvic pain. Constriction at the groin in boys may result from improperly adjusted braces. Pressure in the axillae due to the rapid outgrowing of jackets and overcoats may be avoided by the use of the Raglan sleeve. It is particularly important that there should be no curtailment of chest expansion. All joint movements should be free.

The fabric of children's underclothing should be smooth, loosely woven and non-irritant. Garments of open cellular fabric which wash readily are much to be preferred to those of close texture. Silk is cool in summer and warm in winter, but its use is generally precluded on grounds of expense. Cotton, a rapid conductor of heat, readily induces chill when its wearer perspires, and so is ill-adapted for children. No undergarment should be duplicated. A vest and pants are more hygienic than combinations. 'Chest protectors' are objectionable.

The outermost garments should be reasonably draught-proof. Cooling of the body is due rather to air velocity than to actual air temperature, and the faster the air movement the more risk to the body, especially when the individual is heated after strenuous exercise. Light, closely woven tweed is an admirable fabric for the outer clothing.

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[1] Page 582.

The garments should be simple in design and free from complicated fastenings. This enables the child to dress himself, and so fosters independence. The need for easy removal of the clothing in such emergencies as burning or scalding is obvious.

The clothing should be light in colour. First, because brightly-coloured garments are attractive and have a valued psychological effect. On this account the child should, within reasonable limits, be allowed to choose his outfit and so develop taste and a pride in dress. Second, because light-coloured materials soon show soiling and are thus likely to be washed more often. The frequent cleansing of clothing, too, is a useful object lesson for children.

The garb of young people should be inexpensive. Modern mass production of children's apparel places simple yet attractive garments within the reach of all at reasonable cost. While it is foolish to pay high prices for clothes which are soon to be worn out by the activities of healthy young children, shoddy should be avoided, as also ill-fitting suits, since older children, and adolescent girls in particular, are often sensitive about their personal appearance.

Clothing should, wherever possible, be non-inflammable. The underwear of poorer children is frequently of flannelette, a fabric which has some of the qualities of wool but is highly combustible. This and other inflammable materials can be rendered partially fire-proof by washing them in water containing a handful of alum, or 1 lb. of sodium tungstate in every two gallons. The treatment should be repeated at each washing.

As to the amount of clothing required, it may in general be stated that no healthy child need wear more than three layers of body clothing. Finery should be avoided as it is soon tawdry. Subject to the points already made, the following outfits for the sexes are suggested.

For girls, a silk-and-wool vest and light wool knickers or panties of reasonable length with a blouse or jersey and a close-texture serge gymnastic tunic are sufficient. A petticoat is superfluous. The outfit may be augmented as necessary by a woollen cardigan: and a suspender bodice or belt is required for stockings. In summer, a sleeveless vest, short loose-fitting knickers of silk or cotton and a frock of similar fabric, with a woollen jacket held in reserve for the evenings or colder spells, are sufficient. Ankle socks should replace stockings. For boys, a silk-and-wool vest, flannel shirt, tweed shorts and wool stockings are the basic garments. Underpants, if worn, should be short and loose. It matters little whether trousers are supported by a belt or by braces, provided that there is no constriction and that the garments are not too tightly hoisted. A knitted pullover or jersey is preferable to a jacket. A waistcoat is unnecessary. In summer, open-neck tennis shirt, light flannel shorts and a blazer are ample, and neither socks nor stockings need be worn.

Each child should be provided with a raincoat of waterproof textile and a greatcoat for warmth in cold weather.

The kilt is a hygienic and attractive dress for boys which merits a wider adoption. It gives carriage, warmth and comfort with perfect freedom of movement, and favours healthy development. It should be of pure wool, made in army style, and supported by buckle and strap. Underpants, if worn, should be of the briefest. One of us found, during the course of an observation extending over several years, that a series of boys aged nine to fifteen, wearing only thin wool vest, flannel shirt, a kilt, a knitted pullover, stockings and leather shoes as their entire clothing in dry winter weather, made no complaint of cold. A tennis shirt, a kilt and leather sandals, with a light wool pullover as required, was their dress in summer. The winter clothing of the boys proved as adequate as that of a control group wearing vest, shirt and pants, all of wool, under a three-piece tweed suit.

Leather shoes are preferable to boots unless in wet weather, or in children whose ankles are weak. Leather sandals with low heels are good summer footwear for children, while rubber-soled shoes for everyday use are unhygienic. Plimsolls should be reserved for the gymnasium or the beach, and rubber Wellington boots for wet weather. Anatoform shoes such as 'Startrite' and similar varieties are to be recommended. The feet of stockings and socks should be roomy. Those which have shrunk to such an extent as to compress the toes should be discarded. A chiropodist should be consulted regarding minor deformities of children's feet.

The wearing of hats by children is largely a matter of choice. The head should be covered during inclement weather or intense sunshine. Tight headbands and elastic chinstraps should be avoided, and the smaller the hat the better. Boys who cycle regularly against cold winds without head covering may in time acquire facial neuralgia.

Adequate sleep is necessary for the maintenance of health, and children who are regularly deprived of the proper amount suffer later from anaemia and nerve disturbances of various kinds. Children up to the age of seven require at least twelve hours sleep and those of twelve to fifteen years should have eleven hours. Bedrooms should be quiet, shaded and well-ventilated. The child should not sleep in clothes worn during the day, and should be taught to hang up undergarments so that they may air during the night. Sleeping suits for the young and pyjamas for older children should be of viyella or similar fabric. Bedclothing should be light in character and mattresses firm. Children should not engage in homework near bedtime, since an active brain militates against sleep.

Nocturnal enuresis occasions much concern both to parents and to staffs of residential establishments for children. In some instances the habit is due to improper training, and in others to local irritation by threadworms or other causes including infections of the urinary tract. It not infrequently is an accompaniment of mental deficiency. In a large proportion of cases, however, it occurs with sensitive and often highly intelligent children, in whom any event which disturbs the mental equilibrium may aggravate the condition. The treatment of a case is always difficult and must vary with the individual. In the first place, causes of reflex irritation should be sought and removed. For the rest, the patient should sleep on a firm, non-sagging mattress in a cool room with the minimum of bed-clothing. The diet should be free from nitrogenous excess, but rich in fat and carbohydrate, and no fluids should be taken after 6 p.m. Any excitement near bed time should be controlled if necessary by the use of chloral or bromide. The attitude of the parent should be one of quiet confidence and the importance of the enuresis should be minimised to the patient. Encouragement should take the place of punishment, and much may be accomplished by enlisting the co-operation of the child. Alkaline mixtures are often helpful in diminishing irritability of the micturition centre, and constipation should be treated. Hypnotic suggestion in expert hands has given good results in severe and intractable cases.

Meals and Milk. It will be a duty imposed by the Minister, or in Scotland the Secretary of State, on education authorities that they provide milk, meals and other refreshments for pupils in attendance at Schools and County Colleges, or in Scotland Junior Colleges. Regulations made by the Minister and the Secretary of State are to determine who will defray the cost, and what buildings, equipment and service will be in order. Importance is attached in Scotland to the midday meal, and provision is made for certain pupils to have their milk and midday meal on days when school does not meet. The vogue of school meals increased during the Second World War, and under post-war conditions will be further developed. The milk-in-schools scheme introduced by the Milk Marketing Board made milk available to school children at half the usual cost.

It is important that hot meals should be served up hot. When the kitchen and dining-room adjoin there is no difficulty. Where the food is cooked in a central *dépôt* and distributed in vans to the different schools it should be packed in effectively insulated containers so that it does not cool down *en route.*

Provision of Clothing. Where it appears to an education authority that a registered pupil at any school maintained by them is unable by reason of the inadequacy of his clothing to take full advantage of the education provided, the authority may furnish him with such clothing as is necessary to ensure that he is sufficiently clad while he remains a pupil at the school.

'Education' in this connection includes physical exercise. 'Clothing' includes boots and other footwear.

Open-Air Teaching may take place in any playground or in a park. The open-air school building is usually in a suburb. Two acres should be allowed for a school of 100 children. The class rooms should be made to open freely to the air as required. There should be facilities for the supply of meals. The children must be clad to suit the weather (Fig. 21) warm clothing being issued on loan where necessary. The open-air recovery school is good for cases of anaemia and rickets or debilitated and nervous children. The open-air residential school is highly beneficial also in such cases. The period of residence at the open-air school is usually six months or longer, save in post-tonsillectomy and similar cases where it may be four to six weeks. At day open-air schools three meals are provided and arrangements are made for the transport of children to and from their homes. Open-air schools should be visited by a school medical officer once weekly, and by a school dentist periodically, and whole- or part-time school nurses should be employed.

Employed Children should be a special care of the education authority. The school medical officer should inspect them regularly and where necessary report to the education authority for action.

Choice of Employment. The school medical officer in examining leavers should make a note on their medical record cards as to their fitness for employment. This record may be a factor in determining their trade or occupation on leaving school. Particulars from it, as noted elsewhere, must be made available, on request, to the examining surgeon under the Factories Act, and also in terms of the national health insurance scheme to an insurance practitioner accepting for treatment a young person under the age of 18. The vocational aptitudes of the children should also be appraised at this stage, by means of special tests and otherwise. With a view to the further guidance of the young entrants into industry the education authority may appoint a Juvenile Employment Officer to interview employers, examining surgeons, school medical officers, head teachers and others on their behalf. In some areas After-Care Committees play a useful part in the scheme and Careers Councils also take a valued share in the work.

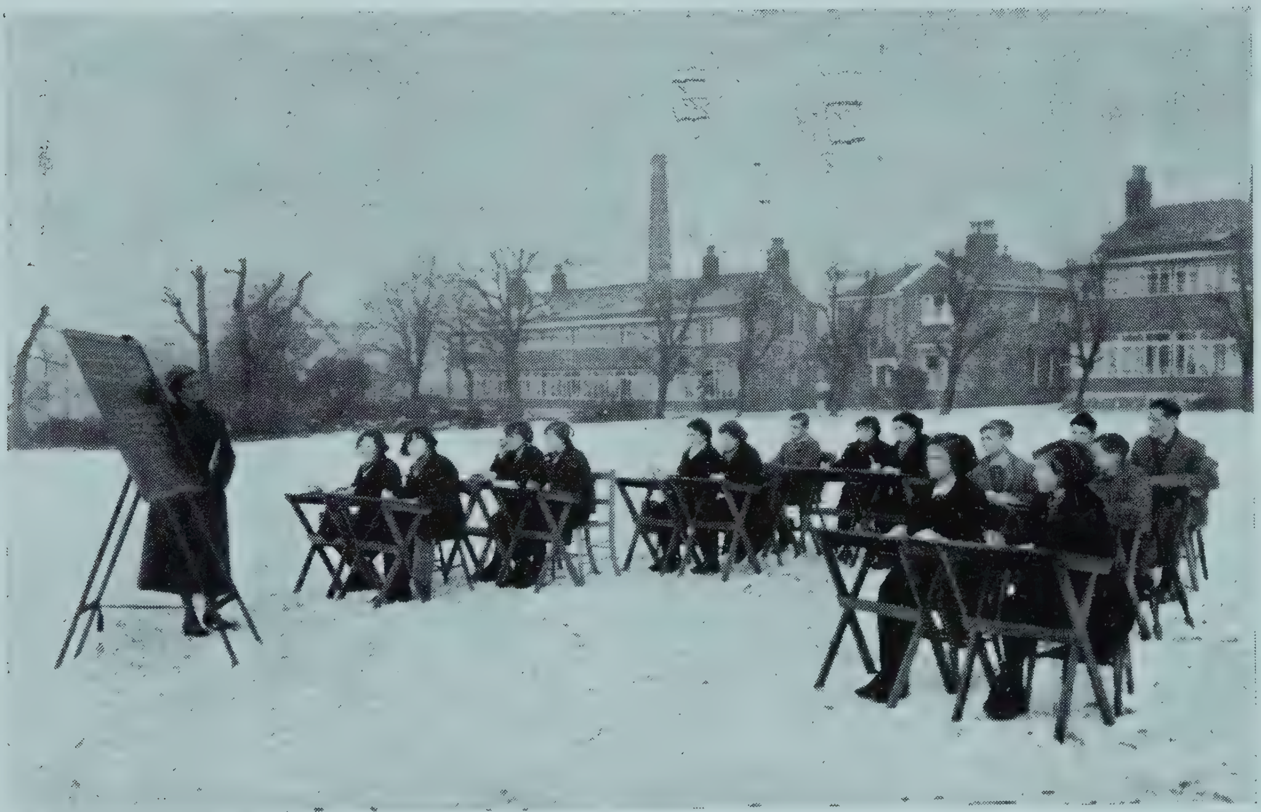

Fig. 21.—Open Air School.

A class in a residential school for tuberculous children.

The education authority may also provide special vocational training for physically crippled 'young persons' with the object of preparing them, as far as may be possible, for a trade or employment befitting their infirmity.

V.

MENTAL HYGIENE

By the British classification abnormal mental states fall into two main groups: mental deficiency, either intellectual or moral, occurring in early life: and lunacy, occurring later in life and including all other forms. The classification has been criticised, but the broad division which it makes is at least administratively sound, since as regards the methods of control of mental states there are fairly constant differences between the two main groups. It will therefore be convenient in this section on mental hygiene, by which is meant the control of abnormal mental states, to deal with the subject under the two heads of (1) Mental Deficiency and (2) Other Mental Disorder.

MENTAL DEFICIENCY

Mental Defectiveness is defined in the Mental Deficiency Act, 1927, as 'a condition of arrested or incomplete development of mind existing before the age of 18 years, whether arising from inherent causes or induced by disease or injury.' The number of mental defectives in England and Wales has been estimated as 8 per thousand of population. The incidence in general is higher in rural than in urban districts.

MENTAL TESTS

The extent of mental development and the degrees of mental deficiency are appraised by means of mental tests. These include Individual and Group Intelligence Tests, Educational Tests, Special Aptitude Tests, Sensori-Motor Tests and Personality Tests. While useful they are not infallible, and wherever possible they should be controlled by an *ensemble* study, including medical and family history, home conditions, behaviour record and other points.

Individual Intelligence Tests, as originally devised by Binet and Simon, have been developed by later observers, notably by Terman, Stutsman, Burt, and Drever and Collins. They deal with perception, memory, reason and similar evidences of native intelligence. The researches of Spearman and his co-workers have shown that human ability may be regarded as consisting of a 'massive' factor, now denoted by 'g,' together with a large number of special aptitudes which are denoted by 's.' On this hypothesis the ability of an individual in any set of circumstances will depend upon the extent to which he possesses 'g' and 's' factors respectively. The 'g' factor appears to correspond closely with general intelligence and may therefore be measured by standardised mental tests. It has been demonstrated experimentally that it increases rapidly during early years of life to a maximum at 15, after which it remains constant. For the determination of 's' factors specially modified intelligence tests are required. Intelligence tests take a variety of forms and include the Binet-Stanford Scale, the Herring Point Scale, the Terman-Merrill 'L' and 'M' Forms, the Burt Scale of Reasoning, Cattell's Dartington Scale and the Penrose-Raven Perceptual Tests. In some instances the tests are verbal, while in others a printed form is supplied to the testee. In a few examples, especially those designed for young children, simple tasks with play material are set. In all cases the questions or tasks to be put are so arranged that a normal child of a specified age should be able to answer the questions listed for that age. For example, one of the tests for a child of 5 is that it should be able to name four colours, while one of the tests for a child of 9 is that it should be able to tell the time from a watch. A child of 12 who is unable to pass any tests from age 9 upwards but is able to pass the tests for age 8 is said to have a mental age of 8.

The Intelligence Quotient, written I.Q., often loosely called the Mental Ratio, is the mental age divided by the time age expressed as a percentage. For the child of 12, referred to above, with a mental age of 8

$$\text{I.Q} = \frac{8}{12} \times 100 = 66,$$

which signifies feeble-mindedness. For the higher ages the tests are designed so that either a selective or an inventive answer may be returned. That is to say, the subject may choose his answer from a number of possibles supplied, or he may make up his own answer. The latter method is regarded by experts as the better. Most of the tests have a time limit which should be accurately observed. If intelligence tests are to be reliable they must be standardised and on this account tests formulated by teachers for local use lose much of their value. Where intelligence tests, graduated up to the age of, say, 14, are extended to include older ages also, the time age for the purposes of the intelligence quotient is taken as the actual time age or 14, whichever is the less. An intelligence quotient of 75 upwards may be regarded as normal. Between 70 and 75 is debateable land. The average for normal persons is between 90 and 110. Supernormals may rise to 140 and over. It is inadvisable to calculate the I.Q. from a single test score, since the standardisation of tests varies and a more reliable result is obtained by striking the mean of several scores obtained from different tests. The intelligence quotient remains remarkably constant during both child and adult life, but it may be affected by certain diseases.

Performance Tests are useful for children who have little aptitude with words but may nevertheless exhibit practical competence in various ways. They imply the use of apparatus and, though giving a lower correlation with intelligence than the verbal tests, are widely used. They are less well standardised than the Binet tests, are not infrequently cumbersome and are usually expensive. But they have an important place in testing deaf, foreign or illiterate subjects. They are also of considerable value in assessing temperamental qualities such as anger, impulsiveness and foresight. The I.Q. which they yield is not constant and tends to be influenced by emotional maladjustment in the testee. Form Boards, Picture Completion Tests, and Mazes are well-known examples of performance tests.

Group Intelligence Tests, which are mainly of the time variety, are designed to be applied to a large number of children simultaneously. They are easier to apply and simpler to score than the individual tests and demand less experience in the tester. Most are unsuitable for children below the age of 10 years. They are more easily standardised than the individual tests and can be so constructed as to provide an assessment of almost pure 'g' quality. It is the consensus of opinion of practising psychologists, however, that they are less reliable for a given member of the group than are the individual tests. They have nevertheless a distinct value in comparing the capabilities of a group with those of equivalent-age norms. Examples of the tests include the 'Simplex' Test, the Moray House Tests, the Penrose-Raven Matrices and Group Tests 33 and 34 of the National Institute of Industrial Psychology.

Educational Tests, known also as Attainment or Achievement tests, are for the assessment of acquired knowledge or skill. In applying these, account must be taken of such disturbing factors as frequent absence from school. They may take the form of examinations, or of standardised scholastic tests either on the individual or group plan. They are of value in grading pupils at the beginning of a school year, and helpful to the clinical psychologist. The dual purpose of school examinations is to gauge the educational performance of a pupil and to furnish a pointer to his possible future achievement. They have long been the subject of controversy and criticism, and much attention is now being devoted to the formulation of new-type examinations which shall be free from the demerits of the past. Standardised educational tests are not designed to cover work done but are intended to demonstrate the general attainment of a pupil or group as compared with similar-age norms. Thus a child of 5 should be able to read 'sun,' to spell 'up' and to answer 'Take 2 from 4. How many is that?' A child of 9 should be able to read 'fringe,' to spell 'table' and to divide one shilling and threepence equally among ten boys. For complex attainments such as handwriting and drawing, Quality Scale tests are now available. These are series of specimens chosen as representing standard age levels of achievement. The pupil under test is required to write or draw a selected specimen in his own way and his effort is compared with that upon the scale. The scale specimens are already scored, so that assessment is automatic. Lately, the conceptions of an Attainment Ratio and an Education Ratio based on the application of these tests have arisen. The ratios obtained will however largely depend upon the type of school, the method of teaching and other factors. For older defectives the silent reading test may be employed. The writing of coherent English composition is beyond the power of most mental defectives.

Special Ability Tests are designed to assess manual dexterity, mechanical aptitude, clerical ability and the like. Examples include the Stenquist Assembly Test, the Warnes Tool Test and the Rogers Stenographic Test. It should be borne in mind that not all aptitudes are constitutional, as is the 'g' factor, but in many cases represent an acquired skill. On this account the test score may be partly due to aptitude and partly to attainment. Psychologists are however agreed that there exists in the intelligence a 'practical ability' factor which has been designated 'F,' and is probably akin to planning capacity.

Sensori Motor Tests are concerned with the assessment of balance, reaction time, colour vision, auditory acuity and the like, and employ such apparatus as the dynamometer, the pneumograph, the pursuit meter, the Ishihara charts and the pure tone audiometer.

Personality Tests include the Downey Will-Temperament Test, the Attitude Scale, the Mosaics Test, the Rorschach Inkspots and Projection Tests generally. They are intended to assess perseverance, personality, association fluency and other traits of character.

Mental testing should be performed only by impartial persons who have been trained both in application and scoring. The instructions accompanying each test, especially those dealing with timing and scoring, should be rigidly followed. The test should take place in a room free from distractions.

GRADES

The Mental Deficiency Act, 1927, taking social competence as the criterion, divides mental defectives into three ascending grades, namely, idiots, imbeciles and feeble-minded persons, together with a fourth group, the moral defectives.[1]

Idiots in the eye of the law are 'persons in whose case there exists[2] mental defectiveness of such a degree that they are unable to guard themselves against common physical dangers.' Idiots are usually stunted, repulsive and ungainly, and often paralysed or subject to fits. They may sometimes be destructive or violent. A few monosyllables form the speech in the average case. Most idiots are sterile and all are prone to such diseases as tuberculosis. They constitute the lowest grade of mental defective. Having no power of attention they are inaccessible to the ordinary mental tests. Their mental age may be put at 2 years or less, and their intelligence quotient below 20. They compose 0·3 per thousand of the population of England and Wales.

Imbeciles are 'persons in whose case there exists[2] mental defectiveness which, though not amounting to idiocy, is yet so pronounced that they are incapable of managing themselves or their affairs, or in the case of children of being taught to do so.' The imbeciles rank in order next above the idiots inasmuch as they can guard themselves against physical dangers.

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[1] In the United States feeble-minded persons are termed 'morons,' and mental defectives in general are described as 'feeble-minded.' In Scotland moral defectives are referred to as 'moral imbeciles.'

[2] In Scots law the mental defectiveness must date 'from birth or from an early age.'

Their gait and posture are often clumsy. Many have a vacuous grin. The attention of imbeciles is short-lived, their instructional memory weak, and their reasoning power zero. They are in a few cases educable and can be taught habits of cleanliness. Of adult imbeciles it has been said that they can neither earn an independent livelihood nor can they contribute materially to their own support. The mental age of imbeciles is between 3 and 7 years. Their intelligence quotient ranges from 20 to 50. The imbecility rate per thousand of population in England and Wales is for urban areas 1·2, for rural areas 1·8.

Feeble-minded persons are those 'in whose case there exists[1] mental defectiveness which, though not amounting to imbecility, is yet so pronounced that they require care, supervision and control for their own protection or for the protection of others, and in the case of children that by reason of such defectiveness they appear to be permanently incapable of receiving proper benefit from the instruction in ordinary schools.' Feeble-minded persons may exhibit no obvious anatomical stigmata and indeed may be not uncomely in appearance. Both in school and afterwards their attainments vary widely. Some may be *idiots savants*, highly accomplished in special fields such as the rapid addition of formidable rows of figures. But they all lack common sense: they are shiftless, unstable, incapable of sustained mental effort and, being without fixity of purpose, are easily led into minor crime. Their mental age ranges from 7 to 12 and their intelligence quotient from 50 to 70 or in some cases 75. In England and Wales they number 5·2 per thousand in towns and 8·2 per thousand in the country districts.

Moral Defectives are 'persons in whose case there exists[2] mental defectiveness coupled with strongly vicious or criminal propensities, and who require care, supervision and control for the protection of others.' The mental state is usually one of feeble-mindedness, often accompanied by a certain low cunning. The diagnosis of moral defect should, if possible, be avoided in the case of a child. In the case, however, of an adolescent who exhibits persistent and recidivist delinquency on which admonition or punishment produces little or no deterrent effect, and who at the same time suffers from mental defect involving perversion or abnegation of the moral sense, certification may be necessary with a view to his detention in a custodial institution. Mental defectiveness *plus* delinquency does not necessarily constitute moral defectiveness, for mental defectives in a vicious environment are easily persuaded into crime and just as easily persuaded out of it when removed to more edifying surroundings.

AETIOLOGY

According to what is believed to be their aetiology mental defects have been classed as (1) primary or endogenous, due to germinal causes and (2) secondary or exogenous, due to extraneous causes. This classification is recognised in the legal definition already quoted. The respective frequency of the action of germinal and extraneous causes has been variously stated by authors. Some have ascribed to both a 50 per cent.

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[1] In Scots law the mental defectiveness must date 'from birth or from an early age.'
[2] In Scots law the conditions referred to must date 'from an early age.'

value: others have put the germinal causes as high as 90 per cent. It may at least be anticipated from these findings that germinal causes play a substantial part in mental deficiency.

Germinal Causes

The familial incidence of mental defect has repeatedly been recorded through several generations and has been found to be higher in such cases than in families chosen at random. Now and again a defect has been observed to figure as a Mendelian dominant or recessive, but in the majority of cases the genetic pattern remains rather obscure, possibly owing in a few instances to blurring of the design by environmental influences, but most often to the fact that mental deficiency itself is not a heritable unit but may exist in many forms of varying genetic type which have not yet been separated out from one another. Despite these difficulties, which further study may ultimately resolve, the evidence from familial concentration is too strong to be set aside, and mental deficiency must be regarded as in many cases heritable. Examples of such hereditary defects are Amaurotic Idiocy, Micrencephaly and Mongolism.

Amaurotic Familial Idiocy. Known also as the Tay Sachs disease. The infant, usually of a Jewish family, becomes blind during the first year of life. Later there is atonic limb paralysis. Asthenia supervenes and few cases survive 3 years of age. There is atrophy of the optic nerve together with a cherry-red spot in the region of the macula lutea. The senses of taste and hearing are preserved. In the post-infantile type of the affection, more common in Gentile families, the cherry-red spot is not observed.

Micrencephaly. In this condition the skull is conical, with a circumference measured at the eyebrows not exceeding 17 inches. There is marked recession of the forehead and chin, the occiput is flat, the scalp is furrowed and the anterior fontanelle is commonly absent at birth. The development arrest is most marked in the temporo-sphenoidal and occipital lobes of the brain. The gait is spastic and limb deformities are not unusual. The stature may be low and there is not infrequently infantilism. Micrencephalics are prone to tuberculosis, and there are convulsions in more than half of the cases. Their mental grades are idiocy and imbecility.

Mongolism. The stigmata of Mongolian idiocy are a flat square face with bulging brow and slanting eyes. The tongue is hypertrophied and transversely fissured. Ocular defects such as ectropion and strabismus are frequent, and club foot, cleft palate or other skeletal defects are often present. The hands are short and broad and the fingers hyperextensible. The feet are characteristically clumsy and show a marked cleft between the great and second toes. Owing to congenital defects of the cardiac foramen ovale and interventricular septum the complexion is frequently bluish. The skin is dry and the hair sparse though silky. Mongols have an affectionate disposition, and may from their imitative faculty appear bright and intelligent. They almost always show a fondness for music and their sense of rhythm renders them apt in drill and dancing. In fact, the mental state varies from feeble-mindedness to idiocy. Many die at young ages although a few survive puberty and may under sheltered conditions reach middle age. No mongol woman has yet borne a living child.

Sterilisation

In the case of mental defects credibly traced to germinal causes, it is clear that the sterilisation, by vasectomy in males and salpingectomy in females, of individuals exhibiting such defects would effectively prevent such individuals from transmitting their defects, whether dominant or recessive, to future generations. But, if extended on a national basis to all persons exhibiting the defects in the hope of a speedy eradication of the defects from the community, sterilisation will inevitably falsify expectation, since, as already noted in the section on Inheritance, it cannot be applied to the great mass of the heterozygotes, from the mating of whom the major portion of the mental defect in a generation is believed to be derived.

In the North American Union the compulsory sterilisation of selected mental defectives began to be legalised some thirty years ago. The procedure has been employed also in Switzerland, Denmark and in the province of Alberta. In the State of California, where it has had the greatest vogue, the operation may be performed with or without consent and has been used in selected cases more as an administrative convenience than with any definite eugenic object. Mental defectives in institutions there have been sterilised as a condition of discharge or release on probation. It is claimed that this procedure enables patients to be restored to social life who would otherwise have had to be maintained in permanent custody. In reviewing a series of such cases from the large Californian home for defectives at Sonoma, Popenoe found that 72 per cent. of the boys and 65 per cent. of the girls were successful. His criteria of success were consistent good behaviour, the ability to be self-supporting, and contentment. It is of interest to note that the defectives thus sterilised did not on their return to the community embark on a career of profligacy as a matter of course.

In the United Kingdom compulsory sterilisation for selected mental defectives has lately been favoured by some and opposed by others. Those who favour it do so on the grounds (1) that the fertility of mental defectives is alarming, (2) that our knowledge of the genetics of mental defect meets requirements and (3) that the families of mental defectives are unhappy and ill-nurtured. The opponents dispute ground (1) in the belief that the fertility of defectives has been exaggerated—as it has. They take exception to ground (2) because those best entitled to speak say precisely the opposite. They would probably admit ground (3) as showing that mental defectives may prove bad parents without accepting it as an adequate reason for sterilising them. Apart from any argument one way or the other it seems likely that compulsory sterilisation, if introduced at this time, would shock public opinion. It is understood that it would be resisted by the Church of Rome on the ground that a man 'has a natural right to his bodily integrity until he has forfeited that right by crime.'

Voluntary sterilisation, as suggested by the Departmental Committee of 1934, is a possible alternative. Subject to written authorisation by the Minister of Health, certification by two doctors and advice in individual cases by a board of medical men and geneticists, the Committee recommended that voluntary sterilisation should be legalised for (1) mental defectives and persons who have suffered from a mental disorder and (2) persons who are believed to be likely to transmit mental disorder or defect. Group (2) includes the heterozygotes, in so far as identifiable, which is not very far. Numerically the result of giving effect to the Committee's recommendations might not be great, but the inclusion of the heterozygotes is evidence of a eugenic purpose and, with the various safeguards imposed, abuse of the facilities offered would be unlikely to occur.

Extraneous Causes

The secondary or exogenous forms of mental deficiency are the result of causes operating from without, such as injury, specific infection, externally conditioned endocrine dystrophy and sensori-deprivation. Examples of injury are the cerebral lesions from which infants may suffer in consequence of gross cerebral haemorrhages during difficult labour. Examples of specific infection are furnished by the mental flaws which are not uncommon in congenital syphilis and by the so-called post-encephalitic delinquency in cases of encephalitis lethargica. An example of disordered function of an endocrine gland is seen in cretinism, cases of which are classed as pure cretin, semi-cretin and cretinoid, depending among other factors on the degree of iodine shortage. Sensori-deprivation occurs when the mental faculties cease to develop owing to the loss of hearing or sight, or both, as may ensue upon a specific fever. Methods however have been devised to break through the wall of darkness, and in well-known instances a high degree of intellectual accomplishment has been attained. Epilepsy and hydrocephalus are in many cases of extraneous origin.

Cretinism. This defect, which may be either endemic or sporadic, becomes apparent early, usually during the first year of life. Fully developed intra-uterine cretinism which may occur results in still birth, the foetus exhibiting the characteristic conformation. The typical cretin is a speechless dwarf, with a large head, thick features, protruding tongue, dry skin, scanty hair, swollen eyelids, prominent abdomen and usually supraclavicular pads of fat. As a rule the subjects are harmless and amiable. Their mental range is from idiocy to feeble-mindedness. Cretinoids may be able to learn a vocation. Thyroid treatment, which must be continued throughout life, as a rule benefits the physical state in cretinism, while the mental defect does not respond.

Epilepsy. In epileptic mental deficiency, intelligence tests are of uncertain value, since the deterioration, while in part intellectual, may be more pronounced on the side of temperament. The mental ratio however falls as the condition progresses and the fits become more frequent. If the seizures began in early infancy, and are regular, the patient may sink in the end to the grade of idiocy. As a class, epileptic defectives are irresponsible and best to be dealt with in custodial institutions.

Hydrocephalus, which may be congenital or acquired, results from a pathological process in the brain which impedes the normal drainage of the cerebral cavities. It may develop prenatally but is ordinarily noted some time after birth. The anatomical lesion is a distension of the ventricles and especially the lateral ventricles. The expanded dolichocephalic skull of a child 3 years old may have a circumference of 25 inches. Even with extreme dilatation the thinned-out brain may reveal remarkably little interference with function: as a rule however there is mental impairment ranging from feeble-mindedness down to idiocy. In mild cases the mental faculties may be unimpaired. In some cases the process is arrested and the patient survives to adult life: more often however death occurs within the first 5 years. Not infrequently the condition is associated with hare lip, spina bifida or like deformity.

CONTROL OF MENTAL DEFECTIVES

Young Children presenting minor degrees of mental deficiency may escape notice at home or their vagaries of conduct may be leniently construed by their parents. But if it appears to the local education authority that any child in the area who has attained the age of two years is suffering from a disability of mind of such a nature as to make him incapable of receiving education at school, it is the duty of the authority, in terms of the Education Act, 1944, to serve notice upon the parent of the child requiring the parent to submit the child for an examination by a medical officer of the authority. If the parent fails to comply without reasonable excuse he will be liable to a fine on summary conviction. The parent is to receive notice of the time and place of the examination, at which he may be present if he so desires.

If after considering the medical officer's report and any reports or information from teachers or others the authority decide that the child is suffering from a disability of mind of such a nature as to make him incapable of receiving education at school it is the duty of the authority to issue to the local authority for the purposes of the Mental Deficiency Act, 1913, a report that the child has been found incapable of receiving education at school. Before issuing such a report, the local education authority must give to the parent of the child not less than fourteen days notice in writing of their intention to do so, and if within that period the parent refers to the Minister the question whether such a report should be issued, the report must not be issued except by direction of the Minister.

Similar procedure will apply if the child's disability is such as to make it inexpedient that he should be educated in association with other children either in his own interest or theirs.

The Mental Deficiency Acts, 1913[1] to 1927, impose upon the local education authority the duty of ascertaining in each area which children between the ages of 7 and 16 are mentally subnormal. The Acts further require each local authority to set up a Mental Deficiency Committee which shall have the duty of providing supervision, guardianship, accommodation and training for mental defectives as required. The Mental Deficiency Regulations, 1935, require the local authority, in ascertaining whether a child is 'subject to be dealt with' under the Mental Deficiency Acts, to take into consideration such matters as associated physical defect, home circumstances, and need for care or control.

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[1] The equivalent provisions in Scotland are contained in the Mental Deficiency and Lunacy Act, 1913.

School children between the ages of 7 and 16 may, if 'feeble-minded' and not merely dull and backward, be consigned under medical certificate by the education authority to special schools, frequently residential, which give vocational and other training. Special day schools offer general education within the limitations of the pupils up to the age of thirteen, after which in most cases the children are passed to central special schools where vocational training in basket making, simple weaving, toy making and the like is given by teachers qualified in the practice of mental deficiency. The education should include sense and speech training, personal hygiene and posture development. Manual training is especially valuable as an index to future employability. Skilled and sympathetic teachers and small classes are essentials in modern special school work. Special classes in ordinary schools have also been found of service.

On the other hand children between the ages of 7 and 16 who are medically certified to be incapable of receiving benefit from the instruction in special schools or classes are required to be notified by the education authority to the local authority, whose duty it will then be to make provision for supervising them in their homes or at occupational centres or for placing them under guardianship or preferably in certified institutions. The education authority are required further to notify to the local authority, for suitable provision, defective children who cannot be instructed in special schools or classes without detriment to the interests of the other children, and also, subject to the consent of the Board of Education, certified educable defective children deemed suitable to be dealt with under the Mental Deficiency Acts by reason of 'special circumstances' peculiar to themselves.

If the local education authority are satisfied that any child under their care is suffering from a disability of mind of such a nature that he will, in their opinion, require supervision after leaving school it is in terms of the Education Act, 1944, the duty of the authority, before the child ceases to be of compulsory school age, to issue to the local authority for the purposes of the Mental Deficiency Act, 1913, and to the parent of the child, a report that by reason of his disability the child may require supervision after leaving school.

Adults. Mental defectives who first come under notice at adult ages usually do so through becoming destitute or falling into the hands of the police or otherwise exhibiting their need of supervision or guidance. They may include among their number defectives who had formerly been in attendance at special schools but who on leaving had not been notified to the local authority. Their age is necessarily over 16 and most, it has been observed, are under 30. The home supervision of adult defectives may be provided simply by order of the appropriate committee of the local authority. For their maintenance under guardianship or in a certified institution a judicial Order is necessary. To obtain this a petition has to be presented by the local authority to a judge of the County Court or a stipendiary or other specially appointed magistrate. Two medical certificates are required together with a statutory declaration that the defective is 'subject to be dealt with' under the Mental Deficiency Acts. The circumstances[1] which render a defective liable to be so dealt with are:

That he or she has been found neglected or abandoned or without visible means of support or cruelly treated.

That he or she has been represented to the local authority by a parent or guardian as in need of care or training which cannot be provided at home.

That he or she has been found guilty of a criminal offence or has been ordered or found liable to be ordered to be sent to a certified industrial school.

That he or she is in an institution for lunatics, or is an habitual drunkard or, being over the age of 7, has been notified as incapable of receiving benefit from instruction in a special school.

That she has recently given birth to an illegitimate child while in receipt of poor relief, or is pregnant of an illegitimate child and is in receipt of poor relief.

Unless one at least of the above-mentioned circumstances exists the mental defective is not 'subject to be dealt with.'

The judge or magistrate having received the petition may after sundry procedure make an Order sending the defective to a certified institution or placing him under guardianship.

In the case of a defective in urgent need of protection the Court may make an Order for his or her removal to a temporary 'place of safety' such as a workhouse, police station or hospital. A common procedure in such cases is for an officer of the local authority, authorised in that behalf, to remove the defective forthwith pending the presentation of a petition to the Court. In the case of a defective charged with an offence punishable by penal servitude or imprisonment the Court may on its own initiative make an Order placing him or her in a certified institution or under guardianship.

An idiot or imbecile of any age may be placed in a certified institution by his parent or guardian on the presentation duly filled in of the prescribed form accompanied by two medical certificates, one of which is to be given by a medical practitioner approved by the local authority or the Board of Control, and the other, if possible, by the usual medical attendant. A feeble-minded person under 21 can with the consent of the Court be dealt with in a similar manner. A feeble-minded person over 21 is unable to be dealt with at the instance of a parent or guardian.

SOCIAL ADJUSTMENT

Mental deficiency is incurable, as it involves either a primary lack of the higher cerebral neurons or their subsequent destruction by some extraneous cause. Something is lost which the art of medicine can neither restore nor create anew. Even when used as a palliative, whether to correct physical deformities or to improve the general health of the patient, medicine can effect little with the body of the defective, which in general has been found unresponsive to treatment. As regards the effect of education, the limit of the defective's attainment is soon reached on the intellectual side, but on the vocational side a better prospect opens out, since he can be taught to do things useful to himself and others and so is set upon the path which leads to social adjustment.

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[1] Full particulars regarding this and other procedure under the Mental Deficiency Acts, with reprints of the official certification forms, are set forth in *Mental Deficiency Practice* by F. C. Shrubsall and A. C. Williams (University of London Press).

When a defective is admitted to a certified institution, if he is capable of scholastic learning he will receive instruction according to his powers. If he shows a mechanical turn he will get vocational training in cobbling, brush making, tin-plate work or carpentry. He will be given work to do, by which he begins to learn self-reliance. If he promises well he may then be apprenticed to an outside workshop, where he enjoys more freedom and greater responsibility, a combination which tends to develop character. If on the other hand he shows a preference for outdoor activities, he can be taught gardening, later reach a farm colony, and ultimately go out on licence as a hired hand to a neighbouring farmer. He is now earning money and begins to feel that he is a social unit, a cog in the wheel of life. Finally having shown himself steady, willing and industrious he may be recognised as having achieved social competence, and may accordingly be discharged to make his own way in the world, guided perhaps in his initial stages by a voluntary mental welfare association or kindred body.

Other half-way houses for defectives on the road to social competence have been found of service in this country or abroad. Such are lads' hostels in towns: girls' hostels, where the girls go out by day to domestic service in carefully chosen households: and women's hostels designed to supply female labour to industry. All are linked to a central institution and have been well described as 'sheltering arms extended into the community.'

Life in a quiet countryside under the charge of a competent and kindly guardian in a household without young children may do much for the more amenable type of defective. Sharing in the work of the croft and accepted as one of the family, he becomes contented with his lot, though it may on occasion be a disadvantage to him that he is rather out of the way of expert supervision. For the moral defective in an institution who resists every reclaiming effort permanent custody may in the end be found inevitable.

The principle of social adjustment may be made wide-ranging. It can be extended downwards to include the lower types of defective in certified institutions. They have no prospect of ever achieving discharge, but by learning to render humble services—sweeping, fetching, carrying and the like—they come to fit as social units into the life of the sheltered community which constitutes their world.

OTHER MENTAL DISORDER

In the wide field of mental disorder other than mental deficiency, while a hereditary factor may sometimes be apparent, as in schizophrenia and the manic-depressive psychoses, there are many cases in which the native mental equipment must be presumed to be good enough, but function is being impaired by extraneous influences, such as anxiety neuroses or syphilis, which may be amenable to appropriate control. In cases of this type a better response to treatment is to be expected than in deficiency cases. They are the subjects of the cures effected in mental hospitals, by convulsion or other therapy, as a result of which the patient is restored to normal mental health.

It has been felt that the efficacy of psychiatric effort in mental hospitals is hampered by the fact that so many cases are allowed to run on, it may be for months or years, before being brought within the reach of expert treatment. The view is taken that earlier treatment is greatly needed. Changes which have been noticeable lately in the attitude of the people to the whole question of mental disease have tended to favour movement in this direction. The public horror of lunacy as a thing beyond the pale, and of asylums as places for the custody of beings who have ceased to wear the semblance of humanity, is yielding rather slowly to a more enlightened recognition of lunacy as a disease much like any other and of asylums as hospitals for the treatment of that kind of disease. In this clearing atmosphere psychiatry has developed along lines which have much in common with ordinary hospital practice.

One of these good developments is the out-patient psychiatric clinic. Such a clinic should be housed at a general, not a mental, hospital. In this way a visit to it carries no slur. Early cases, sent by doctors, will come to it readily, or be brought by their parents, and so get early treatment. The great majority are treated as out-patients, and some clinics are held in the evening so that employed persons can attend after their day's work. The clinic should be linked to a psychoneurosis or equivalent ward in the general hospital, to which cases found to require indoor treatment can be referred. It should act in liaison with a local committee for mental welfare, in order that contact may be made with the home conditions of patients, since the illness of a number may simply be a reaction to a vicious environment. The out-patient psychiatric clinics have a large turnover of a hopeful type of case, and where their treatment fails they serve as clearing-houses, ensuring early indoor treatment, either in a psychoneurosis ward or in a mental hospital, for cases which stand in need of it.

The Tavistock Clinic in Malet Place, Bloomsbury, exists for the study and treatment of abnormal mental states, including hysteria, neuroses, delinquency, sex aberration and kindred conditions not classed as lunacy or mental defect. The clinic is staffed by trained psychiatrists. Biochemical investigation is a feature of the work. Training is given to post-graduates and others in psychotherapeutic theory and practice. Valuable work in the same field is being carried on also at Maudsley Hospital.

Child guidance clinics too are fruitful of opportunities for applying preventive psychiatry in the case of sensitive, highly strung or maladjusted children who may be referred by medical practitioners, parents or school teachers. The clinic staff should include a psychiatrist, a psychologist and a team of social workers, and should be closely linked with the school medical service, youth organisations and social agencies. The investigation of each case includes a physical and psychological examination of the child, an interview with his parents, a visit to his home and a conference with his school teacher. Among causes for reference of children to the clinic are phobias, neuroses, aggressiveness, theft and truancy. Juvenile courts also enable similar action to be taken, whether the culprit is simply the victim of pernicious example or belongs to the unhappy class of moral defectives.

Young offenders are guided by the Children's Probation Officers, salaried officials, male or female, appointed by the Home Office in terms of the Probation of Offenders Act. The officers are specially selected persons who have been trained in the theory and practice of social science. The delinquent who is on probation is required to observe the conditions of his recognisance,[1] which are furnished to him in a simple written statement. The Probation Officer visits the delinquents, and also those discharged from approved schools and Borstal institutions, advises and encourages them, where possible finds employment for them, conciliates in domestic difficulties and reports to the Court on their behaviour. Broadly speaking the end in view of Probation Officers is to induce their charges to lead honest and industrious lives.

The new and interweaving problems created by evacuation and other results of war made it clear that there was a clamant need for consolidation of the voluntary associations for mental health. In 1942 the Child Guidance Council was accordingly combined with the Mental After-Care Association, the Central Association for Mental Welfare and the National Council for Mental Hygiene to form the Provisional National Council for Mental Health. The Council combines the functions of these voluntary bodies, which included the after-care of defectives and patients suffering from certifiable mental disorder, the dissemination of propaganda relating to mental health, the encouragement of psychiatric-social work and the improvement of teaching in psychiatry.

There is much need for a re-casting of undergraduate courses in mental diseases. More stress must be laid upon the preventive and social aspects of psychiatry and its place against the background of general medicine. There must be training also in the recognition of psychological factors in physical ailments. The importance of the psychosomatic effect in such conditions as asthma, chorea, peptic ulcer and prurigo is now well recognised. The enlightened teaching of mental health, the establishment of a trained psychiatric-social team, the amplification of the neuro-psychiatry research services and the effective co-ordination of mental with general hospitals together form the foundation upon which a sound national service for mental health may be built.

The procedure under the Lunacy Acts for committing a patient to a mental hospital, which involves two certificates declaring that he is of unsound mind altogether with a judicial Order authorising his reception, is in many cases not conducive to early treatment. It is of no use to cases still on the hither side of a mental breakdown, and even in pronounced cases, as to which there can be doubt, it conveys to the friends such an impression of the irrevocable that action is often delayed to the last endurable moment. The milder methods permitted under the Mental Treatment Act, which recognises both voluntary and temporary patients, have been of value in making earlier treatment available to both the types of case referred to above. The relevant provisions of the Act—which applies to England and Wales only—may be thus summarised:

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[1] Called a bond in Scotland.

Mental Treatment Act, 1930

VOLUNTARY PATIENTS

Any person of 16 or over may become a voluntary patient by written application to the medical superintendent of an institution approved by the Board of Control. No medical practitioner need intervene.

Any person under the age of 16 may be placed as a voluntary patient on a written application by his guardian to a medical superintendent as above, accompanied by a recommendation from the patient's own doctor or a practitioner approved by the Board of Control.

A voluntary patient must be released within 72 hours of the receipt of a notice in writing to the person in charge given by himself or his guardian according to his age.

If a voluntary patient becomes unable to express himself as willing or unwilling to stay in the institution he must be discharged within 28 days unless he has in the interval become capable of expressing himself or has been certified likely to benefit by temporary treatment or has been certified as a person of unsound mind.

TEMPORARY PATIENTS

If a patient who is incapable of expressing himself is likely to benefit by temporary treatment he may be received on a written application made by a relative into a rate-aided institution approved by the Board of Control or into the care of a single person so approved.

The application must be accompanied by two medical certificates, one if possible by the patient's own doctor, the other by a practitioner approved by the Board of Control.

A temporary patient may be detained up to 6 months, but if he becomes capable of expressing himself as willing or unwilling to continue to receive treatment he must be discharged within 28 days unless he has again become incapable of expressing himself.

If early recovery seems probable the above period of 6 months may be extended by further periods of 3 months but not exceeding 12 months in all.

The Board of Control may at any time order a temporary patient to be discharged or to be dealt with as a person of unsound mind.

Action cannot be brought for unlawful detention except on the grounds of bad faith or lack of reasonable care, and then only if the plaintiff has obtained leave from the High Court.

VI.

INDUSTRIAL HYGIENE

The aims of industrial hygiene are to advance the health and welfare of the workers in industry, and to protect them against the numerous hazards of their calling. The movement began in 1802 with the Health and Morals of Apprentices Act, to which reference[1] has already been made. This statute reduced the hours of labour and prescribed more hygienic ways of living for a few poor children in textile mills. By 1853 a normal working day of 10 hours had been fixed for all women, young persons and children. The Factory Act of 1864 was the first since 1802 to deal specifically with health: it empowered masters to make rules for cleansing and ventilation. The Act of 1895 was the first to extend protection to men. The most recent statute is the Factories Act of 1937. Its provisions are noted in ensuing pages.

The central authority for British factories is the Factory Department of the Ministry of Labour and National Service, which exercises control through the Chief Inspector of Factories, superintending inspectors and district inspectors. The superintending inspectors are in charge of divisions of the country, while the district inspectors have the care of the districts into which the divisions are sub-divided. The staff of the Department includes general medical inspectors. Examining surgeons are appointed for local areas by the Chief Inspector of Factories from amongst the medical practitioners of each area. Certain matters under the Factories Act are committed to local authorities. Otherwise all administration is through the Factory Department and the Inspectorate.

'Factory' is defined in the Factories Act as any premises in which persons are employed by way of trade or for gain in manual labour for the purpose of making any article, or of altering, repairing, ornamenting, finishing, cleaning, washing or breaking up any article or of adapting any article for sale. The expression includes many other premises also, whether they come under the above definition of a factory or not. Examples are yards or dry docks for ship building or breaking: yarn and cloth mills: locomotive works: printing and book-binding works: film-making works: laundries and certain gas works. Subject to conditions, the provisions of the Act apply also to electrical stations: docks, wharves, quays and places where ships are loaded or unloaded: building operations: engineering constructions and warehouses where mechanical power is used.

'Woman' in the Factories Act means a woman who has attained the age of 18.

'Young Person' means a person who has attained the age of 14 and has not attained the age of 18, but does not include any person whose parent is required by virtue of the Education Acts to cause him (unless there is some reasonable excuse) to attend school or to attend an alternative course within the meaning of the Education Act, 1936.

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[1] Page 4.

Medical men, and especially practitioners in industrial areas, are frequently brought into touch with the problems of industrial hygiene in their daily practice. Ill-health of mind or body revealed in their patients may be attributable to the general conditions of employment or else to the special hazards which attach to a particular trade. The practitioner will often find it useful, when seeing a patient for the first time, to ascertain his occupation. In the trade or process he may discover the explanation of his patient's symptoms. In the interests of his worker patients he should have an acquaintance with the procedure for claiming workmen's compensation.

In the following account of Industrial Hygiene the constituent portions are *first* Factory Conditions, *next* Industrial Welfare, and *finally* the industrial hazards of Poisoning and Disease.

FACTORY CONDITIONS

Health Provisions. Under the Factories Act all factories must be kept clean. The minimum space permitted in work rooms for each person employed is 400 cubic feet. A reasonable temperature must be maintained in work rooms, and if the work is done sitting and does not involve serious physical effort the temperature after the first hour must not fall below 60° F. Ventilation must be adequate and all injurious dust and fumes must be rendered harmless. Lighting, whether natural or artificial, must be sufficient and suitable. All glazed windows and skylights must be kept clean and unobstructed both inside and out, except when shading or whitewashing is necessary to prevent glare. Sanitary conveniences must be sufficient and suitable, and kept clean. Proper separate accommodation must be provided for both sexes. Medical supervision with first aid and preventive treatment may be prescribed by the Secretary of State where illness has occurred owing to the nature of work, or where a process is new or altered or young persons are exposed to risk.

In general, a minimum floor area of 2 square yards per head, excluding the space occupied by machinery, should be allowed. Roofs should not be lower than 9 feet and ceilings should be heat- and glare-resisting.

Ventilation. Wherever possible the general ventilation of a factory should be by the natural method, but it may be aided, if required, by an artificial exhaust. With a view to local air movement the agitator fan is good, or else a jet tube, worked by a pressure fan, which impels a stream of air across a work room above head level. Douches of cold air (Fig. 22) blowing direct on workers give them relief from the heat of tin-plate rolling, glass blowing and similar processes.

Lighting in factories should suffice to afford safe access from one part to another. All dangerous parts of the machinery or plant should be well lighted. Walls and ceilings should be finished in white, yellow or pale grey shades and window space should be large. Good lighting increases output and reduces the frequency of accident. Natural light is better than artificial, and light from the northern sky is the best natural lighting. Dust, which diminishes reflectivity, should be kept under control.

Safety Provisions. In terms of the Factories Act fly-wheels and all moving parts of prime movers must be securely fenced. So also must water turbines, the head and tail races of water wheels, electric generators, transmission machinery such as driving-belts, and the dangerous parts of all other machines. Fixed vessels or pits containing scalding, corrosive or poisonous liquid, unless the edge is 3 feet above the ground or platform, must be securely fenced or covered in. No woman or young person may clean machinery in motion, and no young person may work at any dangerous machine unless after previous training or under adequate supervision. All floors, steps, staircases and gangways must be of sound construction and properly maintained. Where work has to be done inside a tank or enclosed space in which dangerous fumes are liable to be present, the space must be provided with an adequate egress. Before a person enters the space all fumes must be shown by test to be absent. If not, the person entering must wear a safety belt with rope, the free end of which is held by someone outside, or else must be protected by means of a suitable breathing apparatus. Rescue and resuscitation equipments must be readily accessible, and a sufficient number of the persons employed must be practised in their use. Where any dust, gas or vapour liable to explode on ignition is being liberated, adequate precautionary measures must be adopted. In all factories in which more

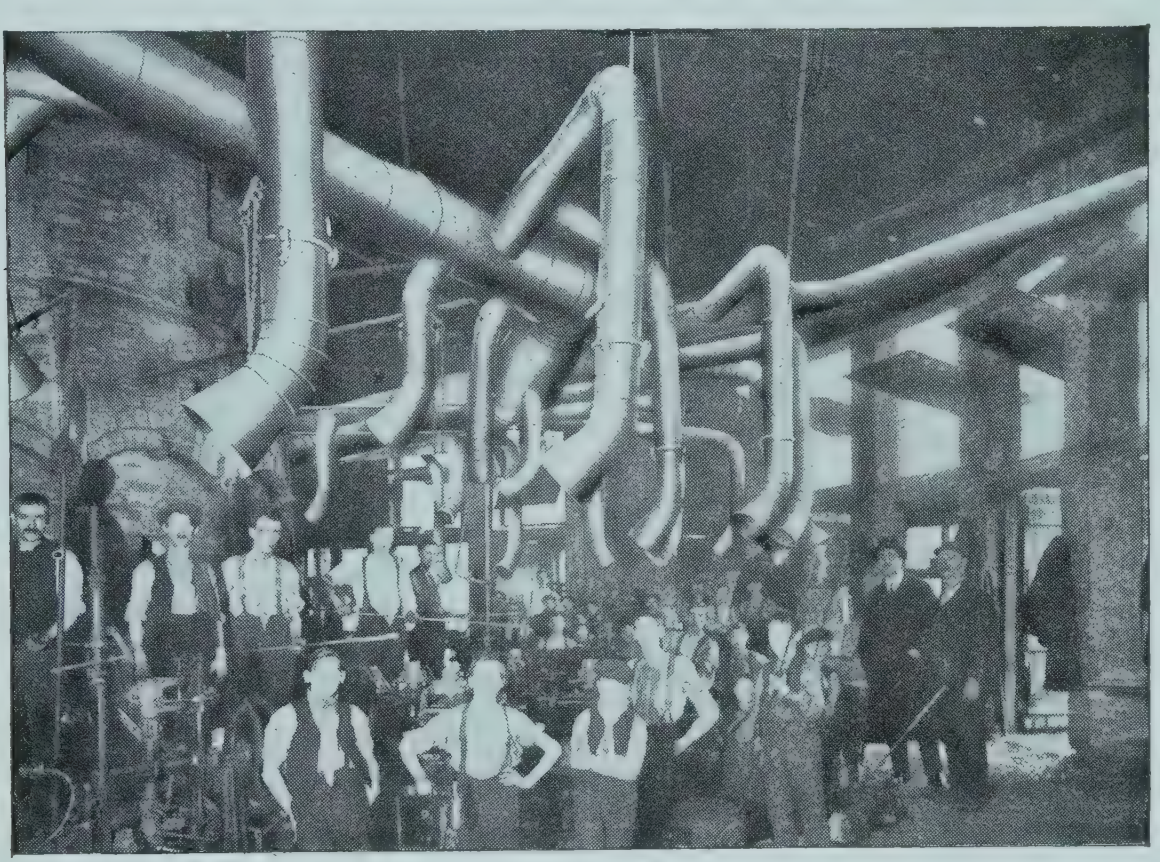


Fig. 22.—Cold Air Douches in Glass Works.

than 20 persons are employed, and in certain others, means of escape i case of fire for the persons employed must be provided. It is the dut of the local authority to cause all factories to be examined and, if prope fire escapes are provided, to issue certificates accordingly. If a factor is occupied in contravention the owner is liable to fine on conviction. A a further precaution, doors must be made to open outwards and al persons employed must be familiarised with the means of escape.

General Provisions. Under the Factories Act an adequate supply o wholesome drinking water must be maintained at suitable point conveniently accessible to employees. Adequate and suitable facilitie for washing must be maintained also and kept in a clean condition Accommodation must be provided, unless in excepted cases, for clothin not worn during working hours. Seats are required to be supplied fo all female workers who have to work standing, in order that they ma rest as opportunity offers. A first-aid box or cupboard must be readil accessible, and where there are over 150 workers an additional box fo every 150. Where more than 50 persons are employed each box mus be under the charge of a responsible person trained in first-aid treatment Or else there must be an ambulance room. The Secretary of State ha made regulations regarding meals, protective clothing, ambulance an first-aid, seats, rest rooms and supervision.

Special Provisions. In terms of the Factories Act exhaust appliance must be provided at danger points to remove injurious dust or fume Where dust or fume of lead or other poisonous substances or siliceou or asbestos dust is freed, no meals may be taken in the room, but th room must be vacated at meal times and arrangements made so that meal can be taken elsewhere in the factory. Where the eyes are in danger from flying fragments, suitable goggles or protective screens must b provided. The Secretary of State may forbid the threading of shuttle by the mouth. No person may use white phosphorus in the manufacture of matches. In artificially humidified rooms there must be a dry and a wet bulb thermometer, which must be read and recorded at stated hours No artificial humidification is permitted when the depression of the we bulb is less than that indicated in a schedule: or in cotton spinning a a temperature over 72·5° F. wet bulb: or in wool spinning and the lik at a temperature over 80° F. wet bulb. In laundries the temperature o the ironing room must be regulated, and steam from the wash hous carried away. Young persons must not be employed to lift weight likely to overstrain them. Female young persons may not be employe where there is melting or, in certain cases, blowing or annealing of glas or the evaporation of brine or the stoving of salt. Women or youn persons may not be employed in certain processes connected with lea manufacture. Where dust or fume is liberated from lead compound women and young persons must not be employed, unless there is sufficient exhaust draught, the persons are medically examined at th prescribed intervals, no meals are taken in work rooms and the rooms ar vacated at meal times, suitable protective clothing is supplied by th occupier of the factory and worn by the workers, and adequate cloak room, mess-room and washing accommodation is provided.

Accident and Disease. Fatal accidents in factories and those disablin for more than three days are required to be notified in the prescribed form to the district inspector of factories. If death supervenes after the notification, written notice of the death must be sent to the inspector by the occupier of the factory. Certain diseases contracted in factories are required to be notified to the chief inspector of factories by medical practitioners. The Secretary of State may direct a formal investigation to be made of such accidents and cases of disease. It is the duty of the examining surgeon to investigate and report in certain cases.

Fitness for Employment. A young person under 16 who is taken into employment in a factory may not remain in employment for 7 days, or longer as may be prescribed, unless he has been examined by the examining surgeon and certified fit for employment. The examining surgeon may in the first place issue a provisional certificate authorising the employment of the young person up to 21 days. The local education authority must on request furnish the examining surgeon with particulars of the school medical record of the young person.

Home Work. Factory occupiers and contractors must keep lists showing the names and addresses of all their home workers and send copies twice in the year to the local authority. If the local authority find that the place where the home work is being done is injurious or dangerous to the health of the people employed, they inform the occupier of the factory or the contractor, who must then within 10 days cease to give out work to be done in the place. Contravention, if proved, constitutes an offence.

INDUSTRIAL WELFARE

The protective purpose of the Factories Act is evident from its safety provisions against injury by machines or corrosive liquids or fumes. But there are also the health and general provisions, the object of which is not to prevent a specific type of accident but to promote the general welfare by keeping the workers in good health and by contributing to their comfort. The employer is bound to provide the fitments but, without the workers' will to make use of the fitments when provided, little result can follow. It was realised by progressive employers that co-operation was the key to the problem. So welfare schemes came.

Welfare Schemes. These schemes have been established at many factories. Their aim is to awaken the interest of workers in the safety and welfare arrangements in vogue at their own factory, and to elicit their co-operation in making these arrangements effective. The schemes are set on foot by the employer, and financed by him. They are usually put under the charge of a welfare supervisor, either man or woman. The supervisor should have been specially trained either by serving an apprenticeship to the work under a competent head or by attending a course of instruction at a school of social science. An impression of the scope of a typical scheme may be derived from the following summary of the duties of a typical supervisor.

The supervisor establishes contact with workers on their entrance to the factory. He may be present at their examination by the examining surgeon. He keeps a record of accidents and illnesses, noting the cause where ascertained. He maintains the discipline of the factory, and arranges the times of holidays. He concerns himself about safety devices, the sufficiency of protective clothing, and the lighting, warming, ventilation and general sanitary condition of the factory premises. He takes an interest in the water supply and drinking cups, in the washing accommodation and changing rooms, in the mess rooms and canteen, the first-aid boxes and ambulance equipment, the provision of seats for women and also rest rooms. In brief, it is for the supervisor to verify that all approved devices for the safety, health and well-being of the employees are made available and are kept in good working order. Enjoying the confidence of both the management and the workers, he can see both sides of questions arising and can thus substantially help in the harmonious working of the factory.

The surge of women during the recent War into munition factories created new welfare problems arising out of the special needs and difficulties of women in industry. A Select Committee which reported on the position recommended *inter alia* that women welfare officers and women in charge of personnel should take a leading part in the selection of women for industry and in the allocation of their work, and further, with a view to an all-round better service, that more use should be made in industry of women doctors.

Works Medical Officers. Many industrial concerns now employ works medical officers either whole- or part-time. Their duties, as described in a memorandum issued by the Factory Department of the Ministry of Labour and National Service, include the organisation of factory first-aid services, the medical examination of personnel, general supervision of factory hygiene and the promotion of health propaganda amongst the workers. The memorandum also suggests that the medical officer should strive to maintain a liaison with local medical practitioners, with the extramural health services and with the local authority.

Industrial Nurses. A Certificate in Industrial Nursing is now granted by the Royal College of Nursing to State Registered Nurses who have completed a special course designed to qualify them to deal with the health problems of industry. The course includes instruction in general hygiene, industrial medicine, infectious disease control, record keeping, first aid and methods of health propaganda. Practical work in the factory supplements the teaching. It is suggested by the College that the duties of the industrial nurse should include assistance to the works medical officer in the medical examination of entrants, employees resuming work after illness and cases of industrial disease. The nurse should also be responsible to him for the efficiency of the ambulance room and other casualty arrangements in the factory, together with the first-aid treatment of injured or sick workers. She should co-operate with the welfare department in matters relating to the health of the employees: elementary propaganda in personal hygiene and safety measures: adjustment of diets for workers who are under medical care: the preparation of reports and the keeping of records. Periodic post-certificate refresher courses are available to enable the nurses to keep up to date.

Canteens. The factory canteen forms an integral part of modern large scale industry and contributes much to the well-being and efficiency of the worker. Not least of its merits is the opportunity which it affords for relaxation. The essential requirements of the industrial canteen are clean, bright accommodation, well-cooked inexpensive food, speedy and efficient service and a friendly atmosphere. Catering may be managed by the factory or else undertaken by an outside firm. The canteen premises should include dining hall, mess rooms, servery, kitchen, scullery, stores, offices and cloakrooms. The dining hall should be wired for broadcasting and equipped for cinematograph projection. A stage, with dressing rooms, is advantageous, and space should be provided for the storage of tables during dances and other entertainments. Mess rooms are for the use of workers who bring their own food and purchase hot drinks on the premises. The kitchen should be furnished with all modern devices which ensure a rapid turnover of meals, including hot cupboards for the storage of fare already cooked. Service of food may be on the 'hatch' principle, each diner collecting his meal direct from the kitchen: on the cafeteria plan, the food being displayed on a sectional servery counter fronting the kitchen: or by waitresses. The last method is costly, one waitress being required for every sixteen diners, but is generally preferred in staff canteens. In large and scattered factories it may be necessary to provide satellite dining rooms which serve light refreshments as well as hot main meals conveyed from the central kitchen in thermostatic food trolleys. When the canteen is run by the factory its management is customarily vested in the welfare supervisor assisted by an employees' committee. Profits, if any, are usually devoted to the recreation club, canteen improvement fund, or works charity.

Extramural. While the activities above described are designed to benefit the worker when he is within the factory, the welfare movement has also extended its helpful enterprise to reach him in his life beyond the factory walls, and schemes representing a range of varied interests have been developed in consequence. Thus a medical service may be provided for health supervision, staffed by doctors engaged on either a whole-time or a part-time footing. Other schemes may offer dental or ophthalmic treatment, or place convalescent homes at the disposal of their members. For educational needs technical classes may be formed and libraries established. Schemes planned to foster thrift may point the way to pensions and superannuation allowances or encourage workers' savings groups.

The schemes which provide wholesome recreation are well organised, and effective for their purpose. For indoor occasions they provide games like chess and badminton, and entertainments such as lunch-time concerts, cinematograph displays and dancing, for all of which room usually exists, or can be made if required, in the factory canteen or recreation pavilion. For outdoor occasions the games are mainly football, lawn tennis or hockey. The exercises may be track running and competitive rowing. Walking expeditions and holiday camps may also be organised.

Likes and Dislikes. The welfare scheme creates a genial atmosphere round about the worker, but his work still remains his most vital interest and may largely determine his outlook on life. If he likes his work, 'fair laughs the morn and soft the zephyr blows.' If he dislikes it, he becomes discontented and begins to cherish a grievance which may darken his whole horizon. If the man were working by himself he could doubtless in many cases rearrange the work to suit himself and so regain contentment, but with the mechanised mass-production of today, which tends to mass-allocation of work without regard to personal faculties or inclinations, deviations from routine to suit individual tastes are for the most part impracticable and so the mal-adjustments continue.

The National Institute for Psychological Research has applied its methods to the problems presented by such cases. It has investigated the aptitudes appropriate to particular occupations and has sought to develop them in chosen workers. By these means the Institute claims to remove discontent. It claims also to promote efficiency and effect economies in running costs. A factory advised by the Institute showed a 25 per cent. increase in the earnings of its workers, and in the case of a restaurant breakages were reduced by one-half. Vocational selection is practised at the Juvenile Advisory Bureaux of the Ministry of Labour and National Service. The young entrants are interviewed, examined by performance and aptitude tests and posted to the approved trade, at which they work for a time under vocational guidance. In the end many make good. Those who turn out misfits may get a fresh start in another occupation.

Where a man likes his work, his liking for it, apart from the value he puts upon it as a means of livelihood, probably springs in most cases from his competence to perform it. In times before the era of mass production, when the worker himself made the article in all its parts from start to finish and could rejoice in it, when completed, as the creation of his hands alone, this feeling of satisfaction amounted to pride of craft and became an inspiration to further or greater achievement. Nowadays under mass production the worker may handle but one small piece, or take but one step out of many, in turning out the finished article. Work of this kind is often easy. Anybody could do it. Hence for the active-minded worker, who feels fit for better things, it possesses no interest, and is worlds away from being an inspiration or source of pride.

It is true that all trades do not merit these strictures. In occupations which demand high skill as in the making of scientific instruments, or arduous physical effort as in the heavy trades, or where the finished article is, like a great ship, a noble creation for all to see, pride of the workers in their craft still holds its place. But the easy repetitive work in the mass manufacture of common articles and commodities which bulks largely in the field of industry, makes no engrossing demand and arouses no uplifting thought: its sole distinction is to have attained to a degree of dullness which, as a contributory cause of fatigue, is one of the problems of industry.

Fatigue. Industrial fatigue, like fatigue elsewhere, is the result of a central motor inhibition not yet fully understood. It reveals itself by a diminished capacity for doing work. It is relieved by rest, as is shown by the 'rest pauses' of men employed in heavy industries. The existence of fatigue among the workers in a factory may be presumed from a lowered output of work either in quantity or quality, or from a rise in the accident rate resulting from the impaired co-ordination of tired muscles. Too little work may lead to fatigue from ennui

The fatigue induced by repetitive work has been referred to. Its onset and progress may be gauged by a falling rate of production. The response of some workers to it is a listless boredom. At the same time there are others to whom the routine, once learned, becomes a source of content. Carrying on their simple process without conscious effort, they withdraw their minds from the environment of the workroom and pass in thought to more edifying scenes. At a test of 31 operatives engaged upon a repetitive task it was found that all but 3 had been 'present yet absent' in this way.

One factor which influences fatigue in the performance of repetitive work is the worker's rhythm or rate of working, which is regarded by E. P. Cathcart as a disposition inherent in the individual. The best work is done, and fatigue is most delayed, when the worker can follow his own natural rhythm, instead of keeping to the pace set for all by the prime mover and conveyed by shafts and belting to the bench machines. An employer, who cut the prime mover out and provided each of his workers with a separate electric motor, under the worker's exclusive control, to drive his machine, found that the various workers ran their machines at different rates, and that the total output was increased.

Among other ways of obviating or relieving fatigue in industry, one is to furnish the right shovel to the man put on to a job of shovelling, since, for example, the blades of the shovels for coke and heavy ore are quite different from one another for equal lifts. Another way is to give, to men carrying loads, the optimum load of half the body weight so disposed as to disturb the centre of gravity of the body as little as possible. It is helpful also to let the standing worker sit down and to allow the sitting worker to stand or move about. In both cases the wearied muscles relax and a new set takes over. In all types of industry, much may be done to combat fatigue by skilled planning of factory lay-out.

No worker can keep on at top pitch through a whole spell. In the heavy trades pauses for rest occur automatically. In light and medium work it has been found expedient to introduce them, as a way of relieving fatigue and keying up production. Thus, when girls labelling packages from 8 a.m. to 12.30 p.m. got a rest pause with a cup of tea from 10.20 to 10.30, their rate of production increased by 13 per cent. An expected pause is more effective than a surprise stoppage. The optimum duration of the break varies with the character of the work. For light repetitive work ten minutes in the middle of a spell, as in the instance quoted above, has usually proved adequate, but failures occur.

Since long shifts engender fatigue, and possibly neurosis, the question of the length of the working day in its relation to necessary output is of importance. It was observed at a number of works that with a shorter day there was increase of the total output, indicating that the workers, when relieved of fatigue, were able to put up a performance the results of which more than balanced the reduction of working time. Where the work was most arduous there the improvement was most marked.

For much that is now known of fatigue and the means for relieving it industry is indebted to the Industrial Health Research Board.

Rehabilitation is the refitting of disabled workers to resume their work or to take up such other work as they may be able to perform. As an appanage of surgery it rounds off the remedial measures of the accident ward and the fracture clinic. In Britain until recently it has been principally organised in connection with war and other injuries, by arranging for further treatment after discharge from hospital or by providing training in appropriate workshops. For persons disabled by tuberculosis, treatment has for long been directed on rehabilitative lines, by way of occupational therapy or vocational training in sanatoria, industrial colonies and village settlements. In the settlements the sheltered worker may become nearly self-supporting but, even when a patient is passed as cured and has qualified himself by vocational training for work in the open market, employers may show little alacrity to engage his services. As regards disablement by diseases other than tuberculosis not much rehabilitation has hitherto been attempted. For all these enterprises every credit is due to the pioneers, but there was no nation-wide scheme. The gap is now filled as under :

Disabled Persons (Employment) Act, 1944. This Act has for its object to make further and better provision for enabling persons handicapped by disablement to secure employment, or work on their own account. A ‘ disabled person ’ is a person who by reason of injury, disease or congenital deformity is substantially handicapped in obtaining or keeping employment, or in undertaking work on his own account suited to his age, experience and qualifications.

The Minister of Labour and National Service will provide under the Act ‘ vocational training courses ’ for disabled persons of 16 years and over who need such training in order to start work. He will also establish ‘ industrial rehabilitation courses ’ for disabled workers of 16 years and over who need restorative treatment and training in order to return to their work or to take up some other work better suited to their condition. Medical supervision will be adequate and the Minister may refund outlays and otherwise remunerate the trainees.

A Register of disabled persons will be established and maintained. An applicant whose disablement is unlikely to last for at least six months will not be registrable. A 1914-18 disablement pensioner may be registered without application.

It will be the duty of an employer who has in his employment not less than 20 persons, or such lower number as may be specified by the Minister, to give employment to registered disabled persons up to the number of his quota. The quota, which will be determined by the Minister, will be of two orders, either (a) a standard percentage or (b) a special percentage. The special percentage may be either less or greater than the standard percentage according to the character of the occupation. An employer may apply to the Minister for the reduction or readjustment of his quota. The Minister may, if he thinks fit, grant a permit for the employment of unregistered persons. Employers will be required to keep registers recording prescribed particulars in respect of their employment of disabled persons. Certain classes of employment, which appear to the Minister to afford specially suitable opportunities for the employment of disabled persons, may be designated by him as classes of employment appropriate to the disabled. In employments so designated no person other than a registered disabled person may be employed.

In the case of registered persons who are so seriously disabled that they are unlikely, either at any time or for a long time ahead, to obtain employment or to work on their own account, facilities may be provided for enabling them to obtain employment or to work under special conditions. Such facilities may be made available by a Company which is required by its constitution to apply its profits, if any, to the promotion of its own objects, and is thereby prohibited from paying any dividends, or by any other association so required and prohibited and approved by the Minister.

The Act will apply to British ships except those employed exclusively outside Great Britain. There will be a National Advisory Council and District Advisory Committees. Expenditure on the ‘ vocational training ’ and ‘ industrial rehabilitation ’ courses and on the ‘ facilities ’ for seriously disabled cases will be defrayed out of moneys provided by Parliament. If at any time there are not enough vacancies in these courses to go round, the Minister may give the preference to disabled ex-service men and women.

Prior to the Act an interim scheme had established useful co-operation between hospitals and the local offices of the Ministry of Labour and National Service. In February, 1946, these arrangements were so adjusted as to give the hospitals guidance on the types of cases constituting residual disablement and in this and other ways to meet the requirements of the Act.

INDUSTRIAL POISONING

General measures for the protection of workers against industrial poisoning have been noted among the provisions of the Factories Act. Details are now presented regarding the poisons themselves, which are grouped as (1) Metallic, (2) Non-Metallic, and (3) Gaseous Poisons.

METALLIC POISONS

Antimony and its salts are employed in the production of alloys, used in the manufacture of Naples yellow and other colours and in the rubber trades. The symptoms of chronic poisoning by antimony include nausea, vertigo, diarrhoea, progressive debility and neuritis. The gait is often affected and there may be disturbance of speech. It has been suggested that some of these effects are possibly due to arsenic with which ores of antimony are frequently contaminated. Exhaust ventilation and protective clothing are prophylactic.

Arsenic. Among the local effects of arsenic are conjunctivitis, eczema, ulceration and in some cases epithelioma of the skin, together with ulceration and perforation of the nasal septum. The systemic effects are anaemia, gastric derangement, pigmentation of the skin, and optic and other neuritis. There is risk from arsenic in the smelting of native metallic sulphides in which it occurs as an impurity, in the fur trades which employ it as a preservative, in the manufacture of arsenical sheep dips and rat poisons, in the glass trade, in taxidermy, in the preparation of colours such as Paris green and in other processes. Poisoning occurs by inhalation or skin contact with the dust of arsenical salts.

especially the oxides. Among the precautionary measures used are exhaust ventilation, protective clothing, automatic packing machinery without personal handling, and washing facilities. The toxic effects of arsine are noted under Gaseous Poisons.

Cadmium is a toxic metal. It occurs in zinc and other ores. In the smelting of such ores cadmium poisoning due to fumes has been reported in operatives. An illness with epigastric pain, vomiting, sore throat and tachycardia which attacked men engaged in electro-welding was ascribed to air-borne traces of cadmium liberated from the electrodes. Cadmium is employed also in metal-plating processes as well as in colour works.

Lead. The most toxic compounds of lead are the basic carbonate $PbCO_3$: $Pb(OH)_2$: the suboxide, Pb_2O : litharge, PbO : and red lead Pb_3O_4. Industrial lead poisoning results from the inhalation of lead or lead salts in the form of dust or fume so fine that the particles can float upon the air. Taking food with unwashed hands is a minor cause. There is no danger in handling metallic lead or lead alloys provided dust is absent. Poisoning sets in as a rule with constipation, headache and pallor. Punctate basophilia may be significant, especially when the granules are large, and the haemoglobin level may be considerably reduced. In many cases however, at the height of the illness, punctate basophilia is absent. Colic, arthralgia and vertigo occur, and usually later wrist drop which may be preceded by weakening of the grip. In chronic cases arteriosclerosis and interstitial nephritis develop. A blue line on the gums, though evidence of lead absorption, is not pathognomonic of lead poisoning. A high rate of lead excretion in the urine and faeces of workers may be an indication of the severity of the hazard but, according to R. A. Kehoe, it does not constitute proof of lead poisoning, the diagnosis of which must rest almost exclusively on the discovery and interpretation of the clinical evidence.

Storage of lead takes place in the bones. In this situation, where it is innocuous, it should be caused to remain during the early stages of treatment by giving a diet rich in calcium together with parathyroid extract. When the acute symptoms have subsided, lead elimination may be attempted, though many consider that this is rarely necessary. Encephalopathy with convulsions, amaurosis and other formidable symptoms is nowadays most uncommon in Britain in the trades with a lead hazard.

In British lead mines where the ore is galena, PbS, there is little or no plumbism. In countries where the ore is cerussite, $PbCO_3$, poisoning is apt to occur.

The one-time high prevalence of lead poisoning in the pottery trades was due to splashing and dust production from the raw lead glazes. The effective measures of prevention employed have been local exhaust ventilation and the use of wet methods, but most of all the introduction of leadless and fritted glazes. In the latter the lead compound is fused to form a silicate, which offers resistance to solution in the body fluids.

Electric accumulators or storage batteries are made by rubbing a paste of litharge, PbO, or red lead, Pb_3O_4, into leaden plates. The process includes the casting of the plates, the mixing of the paste, its application by hand to the plates, then the cutting and trimming of the plates and finally their junction. Mixing, pasting and lead burning involve most risk to the worker. Wet methods, localised exhaust ventilation and periodical medical examination have greatly reduced the incidence of lead poisoning in this industry.

In the white-lead process the casualties have been notably diminished by exhaust ventilation, wet methods, mechanical conveyance and the immediate conversion of the lead pulp into paint by mixture with oil. No completely equivalent substitute for white lead in painting has so far been discovered.

The painting of buildings is responsible for more cases of lead poisoning than any other industrial pursuit, owing to the number of operatives. It is customary both in the case of new work, and when repainting, for the painter to rub down each piece of paint-work in order to get a smooth surface for the reception of the fresh coat. If he uses dry abrasive paper he raises a fine dust which he cannot avoid inhaling. If his paint contains lead, the dust he inhales, being lead-charged, will convey the poison into his body. For the protection of the worker the Lead Paint Regulations, which apply to buildings, including fixtures such as bridges, require old lead paint on wood to be rubbed down in the wet, and forbid a dry rubbing process in the preparation of iron and steel work for repainting. For wood a waterproof sandpaper may be used, and for iron and steel the chipping hammer and wire brush, which detach flakes or large particles. An official leaflet on the causation and prevention of painter's colic is required to be issued to painters. Quick-drying paints frequently contain lead tungstate, which is a toxic substance. Cases of lead poisoning have arisen in artists from the habit of 'brush pointing' with the lips.

In ship-breaking there is lead hazard for men using the oxyacetylene flame to cut lead-painted steel plates or armour plate with red-lead backing. The lead fume generated at the temperature of the flame, which is 3000° F., is said to pass from the lungs directly into the blood. One safeguard for workers in confined spaces is a breathing helmet with tube leading to the open air

Lead Tetraethyl, $Pb(C_2H_5)_4$, is a toxic compound. As first manufactured in the United States it caused a number of casualties. In the proportion of 1 part in 1300 it increases the working capacity of motor spirit. The improved spirit, known as ethyl petrol, is an active skin irritant and should be handled with caution. Otherwise it does not appear to be injurious to motor drivers.

Other toxic compounds of lead employed in industry include the acetate in the manufacture of insecticides, the chromate in wood tinting and the acetate as a mordant in dyeing.

Other industrial processes subject to plumbism are file cutting by hand, from the lead file bed: shot making: and plumbing and soldering.

The measures for the protection of workers against poisoning by lead, as included among the general and special provisions of the Factories Act or as referred to above in connection with processes to which they apply, may be thus summarised: substitution of mechanical methods for personal handling: local exhaust: wet methods: use of protective clothing and respirators: washing facilities: prohibition of meals in work rooms: exclusion of women and young persons from certain lead processes: and the routine medical examination of the workers.

Manganese is employed for making alloys, to increase the hardness of metals, as in manganese steel, bronze and brass. Its compounds are used in dry cells and as disinfectants. They figure also in the glass, ceramic and varnish industries. Toxic effects have been produced by the dust freed during the sorting or grinding of manganese ores and also by fume generated in the course of manganese steel casting. The symptom complex points to a central nervous lesion of Parkinsonian type. The expression is mask-like and the gait spastic. Speech and handwriting may be impaired. Twitchings and tremors occur, and there is emotional disturbance with uncontrollable laughing or crying. Manganese toxaemia may lead to progressive bulbar paralysis. It has been suggested that some relationship exists between exposure to the manganese hazard and the occurrence of pneumonia.

Mercury. The main source of mercurial poisoning is the vapour of metallic mercury, which is given off at mean temperatures and freely evolved in warmth. It is absorbed from the air by the respiratory and digestive tracts and probably may be taken in also through the skin. The symptoms of poisoning are stomatitis, salivation and loosening of the teeth, together with anaemia, erethism and tremor, which last may be shown by changes in the patient's handwriting. In more severe cases retrobulbar neuritis, *petit mal*, loss of memory and psychoneurosis occur. A bluish line may appear on the gums. The hazard chiefly arises from the manufacture of thermometers and similar instruments, the making, repair and cleaning of electric meters, the production of ultra violet ray lamps, and vapour and dust in the hatters', fur-cutting and pottery industries. To prevent the air from becoming charged with mercury vapour in toxic quantity the temperature of work rooms should be kept below 60° F. Floors and benches should be smooth and impervious, and spilt mercury should be gathered up. The vapour may be neutralised by spraying the floors with ammonium hydrate. Carious teeth occurring in operatives should be filled or extracted.

Nickel figures as a poisonous metal in nickel carbonyl, $Ni(CO)_4$, a volatile colourless liquid formed at a stage of the Mond process for pure nickel. The vapour of nickel carbonyl is highly toxic, being dangerous in concentrations of 1 part per 1000 of air upwards. Its sooty odour is detectable in a concentration of 1 part per million. When inhaled it passes unchanged into the blood stream, provoking transient symptoms of nausea, slight dyspnoea and giddiness. In the course of some hours dyspnoea returns and cough sets in with cyanosis and blood-stained sputum. Post-mortem the lungs exhibit the signs of pneumonia together with oedema and extensive haemorrhages, and the heart, liver and kidneys may show fatty degeneration. The whole plant should be gas-tight. Casualties are due to leakage. The blue flame of a spirit lamp turns yellow when in contact with nickel carbonyl vapour. By this test a concentration of 1/400,000 of the vapour may be detected.

Zinc. The fumes of metallic zinc liberated in brass founding, when zinc is added to the molten copper, if inhaled by brass founders used to produce in them transient attacks of illness. To these attacks, which were attended by rigors, fever and sweating, the names of brass-founder's ague and zinc chill were originally given. Owing to the introduction of exhaust ventilation 'ague' is nowadays rare among brass founders, but it has been observed lately in welders of manganese bronze which contains zinc, and also in workers using the oxyacetylene flame to cut galvanised iron plates in ship-breaking. As the syndrome may be set up by fumes of other metals besides zinc, the term 'metal fume poisoning' is now generally applied. Precautionary measures are exhaust ventilation and protective clothing.

NON-METALLIC POISONS

Aniline or amidobenzene, $C_6H_5 . NH_2$, is the source of methylene blue, malachite green and other reagents. Poisoning occurs in the aniline manufacture and in aniline dyeing, usually by absorption of the vapour through the lungs, or of the liquid through the skin which the substance quickly penetrates. Cyanosis, due to the formation of methaemoglobin, is an early sign and may follow immediately on exposure, to be succeeded by coma and collapse which lead on to death. In chronic cases of 'anilism' there may be headache, tachycardia, insomnia, eczema and malignant disease of the bladder. The preventive measures are local exhaust ventilation, mechanical manipulation, periodical medical examination and alteration of employment. Washing facilities should be made use of and protective clothing worn. If a worker happens to be splashed with aniline his clothing should forthwith be stripped off and his body washed. Symptomatic treatment, including artificial respiration with administration of oxygen and cardiac stimulants, may be necessary in acute cases. Tetranitromethylaniline, known also as 'tetryl' and employed in the explosives trade to make detonators and fuse caps, is a potent skin irritant, especially at friction points, and can cause severe local oedema and ulceration of the nasal mucosa. In more advanced cases jaundice may occur. A casein iron-oxide barrier cream is a useful prophylactic for tetryl operatives.

Benzene, C_6H_6, is employed in dry cleaning and in the rubber and explosives industries. In acute poisoning the substance acts by direct irritation of the nervous system, producing excitement followed by coma. There may be bleeding from the gums in the early stages. Chronic poisoning is attended by agranulocytosis, with subcutaneous and open haemorrhages in the terminal stages.

Nitrobenzene, $C_6H_5 . NO_2$, which is prepared from benzene, is the source of aniline in the chemical manufacture. It has the odour of oil of bitter almonds and as Essence of Mirbane is used as a perfume for soaps. The symptoms of poisoning are similar to those of aniline. Oxygen and cardiac stimulants should be administered. For grave cases transfusion of blood has been recommended.

Trinitrotoluene, $C_6H_2 . CH_3(NO_2)_3$, known also as Trotyl, is the high explosive T.N.T. It enters the blood by absorption through the skin, by inhalation or by ingestion, and abolishes the oxygen-carrying capacity of haemoglobin. It may also produce dermatitis and cheiropompholyx. The early signs of poisoning are an ashen-blue pallor, giddiness, nausea and air hunger. In severe cases toxic jaundice may develop, with a case mortality up to 30 per cent., acute yellow atrophy of the liver being present in the fatal cases. Aplastic anaemia occurs but is rare. The protective measures are the use of washing facilities: medical supervision: wearing of special clothing: and alternation of work on trinitrotoluene with other less hazardous forms of employment. Exhaust ventilation plant should extract at low levels since T.N.T. is heavier than air. Persons of intemperate habit, those who perspire freely and those prone to respiratory catarrh are unsuitable for work with T.N.T. The risk of poisoning is greater in shell-filling than in manufacturing the explosive. T.N.T. poisoning is a 'Toxic Jaundice,' as is also tetrachlorethane poisoning, referred to below. Treatment includes the administration of oxygen with carbon dioxide, intravenous calcium gluconate and purgation.

Trinitrophenol, $C_6H_2 . (NO_2)_3 OH$, known also as picric acid, is employed in the dyeing trade and in the manufacture of such explosives as lyddite. The symptoms of poisoning include epigastric pain, stomatitis and vertigo, together with yellow coloration of the skin. Exhaust ventilation and the wearing of rubber gloves constitute the preventive measures.

Carbon Bisulphide, CS_2, is made use of in the vulcanising of rubber and in the viscose process for artificial silk. It is a volatile liquid which evaporates freely at room temperature. As it inflames at 150° F. naked lights should not be permitted in its proximity. The symptoms of poisoning by CS_2 include headache, giddiness, tremor and hysteria, sometimes with drowsiness, paralysis, amblyopia or hallucinations. In chronic poisoning an initial stage of excitement may go on to depression and hypochondria. The poison, though rarely fatal, may leave serious permanent effects. Since CS_2 vapour is twice the weight of air a downward exhaust is good. Other protective measures are enclosed machines, short spells, medical examination and alternation of employment.

Nitrous Fumes, even in low concentration, are highly dangerous. They do not as a rule produce immediate symptoms, but after some hours a spasmodic cough develops, with laboured breathing and lividity. Oedema of the lung may ensue and terminate in death. The fumes are given off in the preparation of sulphuric acid, in the engraving, leather and artificial silk trades and in the nitrating processes of the explosives manufacture. The breakage of carboys of nitric acid causes a number of cases. Preventive measures are exhaustion of the fumes through earthenware ducts by means of earthenware fans, and the wearing of specially designed canister respirators.

Phosphorus, as used in the original 'strike anywhere' lucifer match, was white or vitreous phosphorus, the vapours from which, attacking bone through a breach in the periosteum, caused necrosis of the jaw in matchmakers. Anorexia, hepatitis, insomnia and mental retardation constitute the clinical picture in the chronic generalised form of the disease. This lesion has disappeared from Britain owing to the White

Phosphorus Matches Prohibition Act, which was passed in 1908 and consolidated in the Factories Act of 1937. The 'strike anywhere' match of the present day contains the innocuous phosphorus sesquisulphide, P_4S_3. The 'safety' match, which ignites only on the box, has a head composed of $KClO_3$ and other substances, and the striking surface of the box is coated with a preparation containing red or amorphous phosphorus, the manipulation of which is not harmful to operatives. White phosphorus is still employed in the bronze industry, in the production of smoke screens and incendiary bombs and in the manufacture of chemical manures and rat poisons.

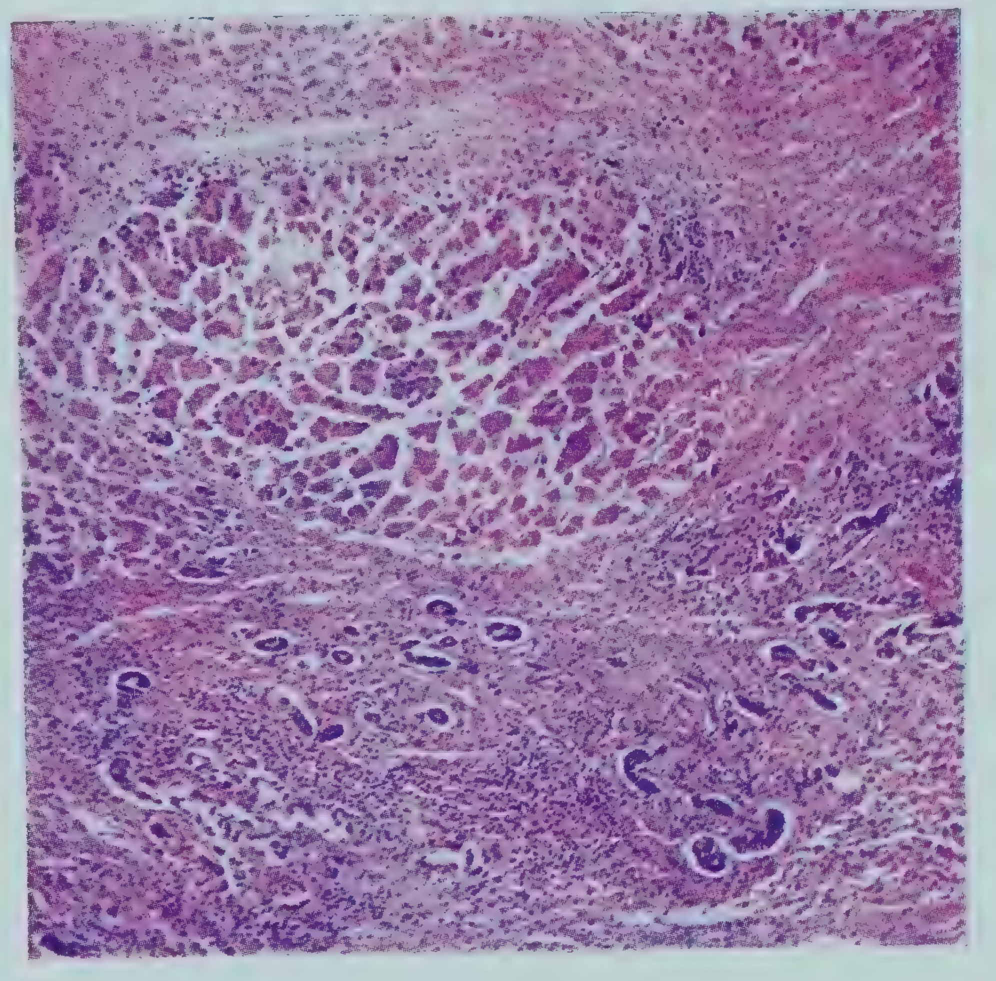


Fig. 23.—Toxic Hepatic Necrosis.

Chlorinated Naphthalene.

Damage to the liver parenchyma is clearly shown.

Tetrachlorethane, or Acetylene Tetrachloride, $C_2H_2Cl_4$, is a solvent for cellulose acetate, bitumen, waxes, sulphur, rubber and other materials. It is one of the substances which give rise to toxic jaundice. Early in the First World War it was employed for proofing the aeroplane fabric, but after causing 70 cases of jaundice with 12 deaths it was prohibited. The sick had inhaled the vapour. The early symptoms included anorexia, headache and mental confusion. In severe cases there were, in addition to the jaundice, muscular twitchings, delirium and coma. Treatment was by oxygen inhalation and blood transfusion. Tetrachlorethane still has commercial uses, for dry cleaning and lacquering, in the film and rubber trades, and in the manufacture of safety glass and parasiticides.

Diethylene Dioxide, known also as 'dioxan,' is a volatile liquid which figures as an intermediate in various organic syntheses, as a solvent for waxes, resins and greases, and in the lacquer trade. Its fumes are irritant to mucous membranes and, in high concentrations, endanger life.

Tri-o-cresyl Phosphate is employed in the production of pyroxyllin lacquers, as a substitute for camphor in the manufacture of celluloid and in the plastics industry. The toxic effect, which is cumulative, is shown by gastro-intestinal symptoms, hysteria, formication and, in advanced cases, permanent paralysis.

Chlorinated Naphthalene is a waxy substance employed to insulate electric cables and as an action controller in the plating of metals. It figures also in the waterproofing of fabrics and in the sealing of condensers and coils. When overheated it liberates a vapour which may produce toxic hepatic necrosis (Fig. 23). It frequently gives rise to dermatitis and to the intractable acneiform folliculitis known as 'chloracne' (Fig. 24).

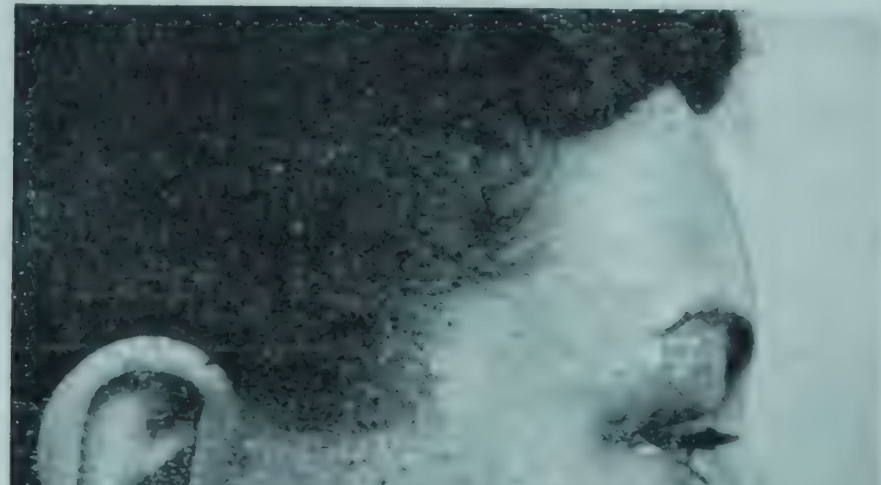


Fig. 24.—Chloracne of Face.

Methyl Bromide, CH_3Br, is employed in the colour trades, in the manufacture of antipyrin and in certain types of fire extinguishers. Inhalation of its toxic vapour leads first to vertigo and drowsiness and later to motor and sensory paralyses. In some instances delirium or mania occurs.

GASEOUS POISONS

Gassing accidents in industry usually occur in tanks, stills or other confined spaces in which a poisonous gas has accumulated. The gas may act as an asphyxiant which leads to anoxaemia either directly or as the result of a chemical combination with the blood: as an irritant of the respiratory mucosa, with consequent pulmonary oedema: as a volatile substance which alters or destroys haemoglobin: or as a protoplasmic poison. The general safeguards in such cases include the exhibition of cautionary placards, blanketing off of sources of gas, and the removal of residual gas, together with the egress manhole, the life line, the breathing apparatus and the resuscitation outfit.

Arsine, or Arseniuretted Hydrogen, AsH_3, may be generated when arsenical wastes are damped with water, or when H_2SO_4 derived from arsenical pyrites acts on a metal. It is produced also during the roasting of various metallic ores, in soldering and plating, and may occur as an impurity of the hydrogen used to fill barrage and other balloons. Owing to the presence of arsenic in grades of ferrosilicon the exposure of that substance to moisture may liberate arsine. The gas is three times as heavy as air and so tends to gather at low levels. Exposure to a concentration of 1 part in 4000 is rapidly fatal. When inhaled it produces a toxic jaundice of haemolytic origin, attended by cephalalgia, vomiting, haemoglobinuria, haematuria and suppression of urine. Remedial measures are the administration of oxygen and transfusion of blood together with glucose-salines and diuretics. Free ventilation should be the rule in stores containing arseniferous materials, especially ferrosilicon.

Carbon Dioxide, CO_2, is found about breweries, aerated water works and lime kilns. Solid carbon dioxide, marketed as 'dry ice,' figures as a commercial refrigerant. The gas is employed also in fire extinguishers and in the 'inert atmosphere' method of food preservation. In the breweries, poisoning has occurred in connection with the fermenting vats, and elsewhere during the cleaning-out of a carbon dioxide gas meter. A proportion of 3 per cent. of CO_2 in air deepens respiration: 5 per cent. causes panting and 8 per cent. dyspnoea. A concentration of 10 per cent. cannot be endured for more than a minute or two. Oxygen inhalation is remedial.

Carbon Monoxide or Carbonic Oxide, CO, constitutes up to 20 per cent. of coal gas, 40 per cent. of water gas and is present also in other gases used in industry. It is a by-product of blast furnaces, brick ovens and lime kilns, and occurs in the exhaust of internal combustion engines. It is generated in the manufacture of wood charcoal and in the syntheses of celluloid, acetone and phosgene. Concentrations above 0·2 per cent. are dangerous to the life of man. Humidity and high atmospheric temperature accelerate the union of CO with haemoglobin. Cardiac disability predisposes to the toxic effect. In acute CO poisoning there is usually no warning but sudden loss of consciousness. Alternatively coma may be preceded by giddiness, a sense of oppression or a drowsy feeling. Sequelae are paralysis, loss of memory and in a few cases dementia. The blood assumes a cherry-red colour. Spectroscopically, if above 25 per cent. of saturation, it shows in the yellow and green the two absorption bands of carboxyhaemoglobin, which resemble those of oxyhaemoglobin but are a little nearer the violet, and are not displaced by the reduced haemoglobin band on adding ammonium sulphide. The degree of saturation may be determined by Haldane's colorimetric method. In treating a case of CO poisoning, warmth and friction should be applied and the attempt immediately begun to restore respiration. As the blood has a low CO_2 content and breathing may cease from lack of the normal stimulus to the respiratory centre, the gas administered by the inhalation apparatus should consist of 93 per cent. oxygen and 7 per cent. CO_2. The administration should be continued for 20 to 30 minutes. In grave cases the gradual injection of 25 per cent. coramine intravenously is of value. It should be kept in mind that a person may be revived from an acute attack of carbonic oxide gassing only to relapse into unconsciousness with cessation of respiration. Cases must be watched very carefully therefore, and kept at rest.

Hydrogen Sulphide, H_2S, may be inhaled in de-arsenicating sulphuric acid, sludging ammonium sulphide plant, clearing tar stills, repairing sewers and cesspools and other procedures. It is a highly toxic gas. The characteristic odour may be absent from strong concentrations. Exposure to 0·07 per cent. for an hour may prove fatal. In milder cases of poisoning the symptoms are nausea, headache, conjunctival irritation and cough. Continued inhalation may excite convulsions. High concentrations cause almost instant death. For remediable cases the appropriate measures are artificial respiration and the administration of oxygen.

Chlorine is employed in the manufacture of bleaching powder and other disinfectants, in bleaching processes and in metallurgy. Spasm of the glottis, intense dyspnoea and cyanosis are among the symptoms produced by the gas. A person exposed to a concentration of 1 in 10,000 is in imminent danger. Chlorine is a lung irritant and causes death by pulmonary oedema. Chloracne, as pictured above (Fig. 24) may occur in the operatives of plant for the electrolytic manufacture of chlorine, in whom it leads to keratotic pigmentation. The precautionary measures against chlorine include the maintenance of gas-tight plant, the wearing of masks and the routine medical inspection of work people.

Cyanogen derivatives of industrial importance include hydrocyanic acid, cyanogen chloride and the metallic cyanides. The acid occurs in vapour form in the gilding and electro-plating trades, in the Leblanc method for the manufacture of soda and in the aniline-black dyeing process. It is employed also as a disinfestant. Potassium cyanide figures in the extraction of gold and silver, in bronzing and in laboratory work. The symptoms of acute poisoning by cyanogen compounds are nausea, vertigo and dyspnoea, with cold sweats and death in a few hours. In the subacute form of the illness there are lassitude, cough, severe vomiting and cramp. The breath may smell of almonds. Treatment is by the administration of oxygen with 7 per cent. carbon dioxide, and good results have been claimed from the intravenous injection of a 0·1 per cent. solution of chemically pure methylene blue in Ringer's solution. Coramine also may be required. Cyanide dermatitis may appear in those who handle cyanogen compounds.

Other irritant gases or vapours in industry are ammonia, which is employed in refrigerating plant: hydrochloric acid, which figures in a variety of metal trades: phosgene, or carbonyl chloride, which is used in the dyestuffs industry, and is a decomposition product of carbon tetrachloride as employed in fire fighting: phosphine, which occurs in the manufacture of calcium phosphide and in the ferrosilicon steel processes: sulphur dioxide, which is a component of certain disinfectants and is used also as a refrigerant and bleaching agent, as well as in the cellulose trades: and formaldehyde, which appears in the aniline dye industry, in the plastics trade, in the production of photographic and other chemicals and in paper making. Poisoning by these should in general be treated by artificial respiration together with the administration of pure oxygen, not the mixture of oxygen and CO_2, and the alleviation of shock by warmth.

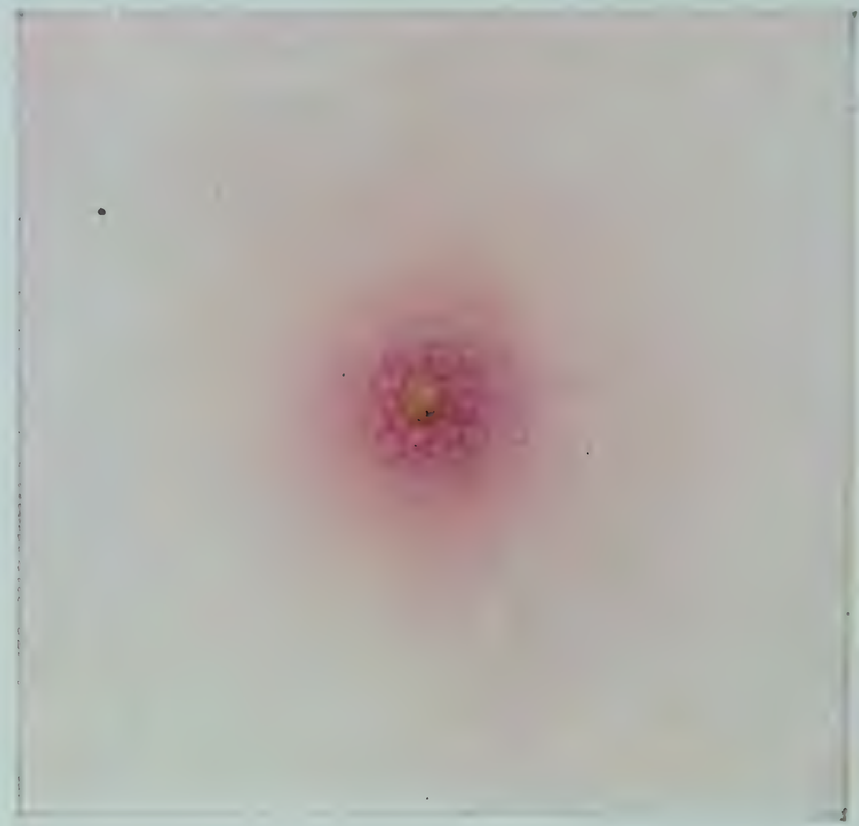
INDUSTRIAL DISEASE

The industrial diseases noted below have the one feature in common that they are all related to a trade, sometimes restricted to one occupation, sometimes spread over several. Some threaten life from the outset: others do so in the course of time. Those that do not extinguish life may induce protracted incapacity.

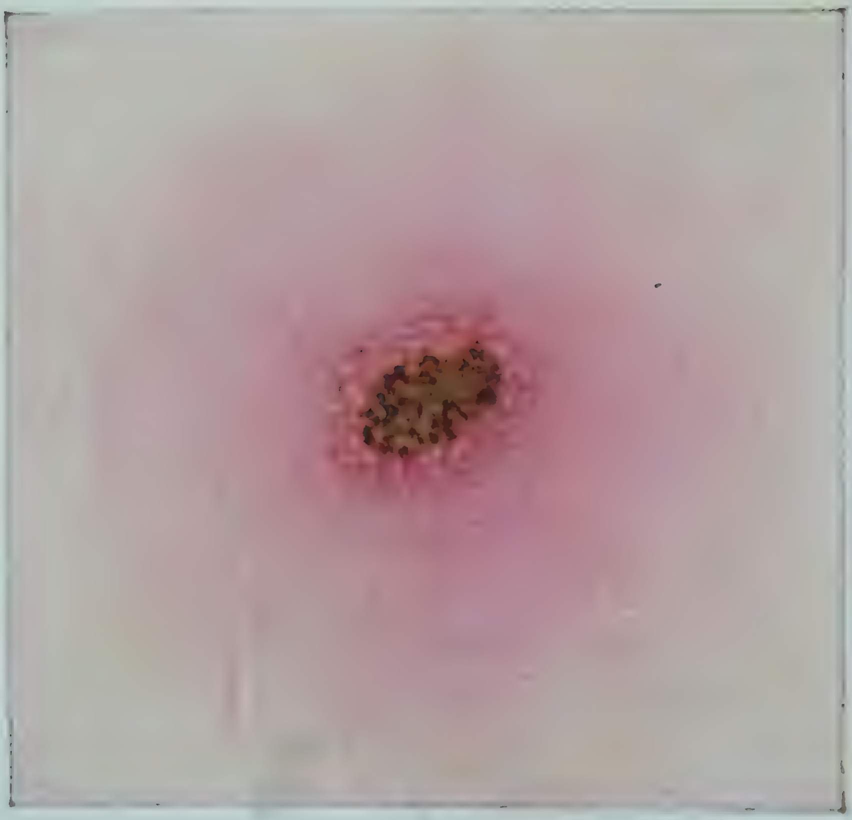
Anthrax

Anthrax is primarily an enzootic of ungulates, especially sheep and cattle, which derive the infection as a gastro-intestinal lesion from contaminated pastures and feeding stuffs. It is believed that insects and snails may carry the infection. The hides and hair of the stricken animals convey the disease to man, in whom it is known in the two principal forms of (1) malignant pustule and (2) wool-sorters' disease, the former the more frequent, the latter almost inevitably fatal.

Malignant Pustule (Fig. 25) occurs in slaughtermen, knackers, hide-porters, tanners and others. A number of cases have in the past been derived from Japanese shaving brushes, the import of which was prohibited by the Order of 1920. Common sites are the face or neck and the forearm, wrist or hand. In a recent series of cases 15 per cent. were fatal. Early recognition of the lesion is important. Direct films from the lesion, stained by Gram's method, may reveal the characteristic bacilli, whose identity must be confirmed by animal inoculation. The most effective treatment is the intravenous injection of Sclavo's anti-anthrax serum in three doses with 12 hours between. Good results have followed the combination of serum with sulphapyridine. Neokharsivan and penicillin are also of service. Excision of the pustule is not advised, but a tablet of $HgCl_2$ strapped upon it has a useful caustic action. A method for the complete disinfection of hides without damage has not yet been evolved on the commercial scale. All workers who handle hides



On 1st or 2nd day.



On 3rd or 4th day.

Fig. 25.—Common Appearances of Anthrax on the Skin.
By kind permission, Controller, H.M. Stationery Office.

should keep any cuts dressed and covered with waterproof tissue, should wash their hands and arms thoroughly and should make themselves acquainted with the appearance of the malignant pustule as pictured in the Cautionary Notice issued by the Factory Department of the Ministry of Labour and National Service. The Anthrax Order of 1938 requires that the carcase of an animal dead of anthrax be destroyed by burning, or, alternatively, by burial at least 6 feet below ground with a surrounding layer of at least 1 foot of quicklime.

Wool-Sorters' Disease, or pulmonary anthrax, is contracted in the handling of wool and hair, usually from Russia, India, Central Asia, Mesopotamia or the Far East. The infective wools are often blood-clotted. In a recent series of fifty-three cases only one survived. Dangerous bales should be opened by skilled workpeople only. The wool should be soaked in water and sorted over a powerful exhaust. Operatives engaged in dust removal and disposal should wear overalls and respirators. Dust and sweepings should be destroyed by burning. Strict cleanliness of workrooms and of the persons employed should be maintained. At the Home Office Anthrax Disinfection Station in Liverpool wool and hair imported from countries specified in an Order are required to be disinfected. In the 'Duckering' process as employed there, the suspect wool or hair is treated successively with weak solutions of sodium carbonate, soap and formaldehyde, all at a temperature of 102° F., and is then washed, dried, cooled and baled. All manipulations are carried out entirely by machinery.

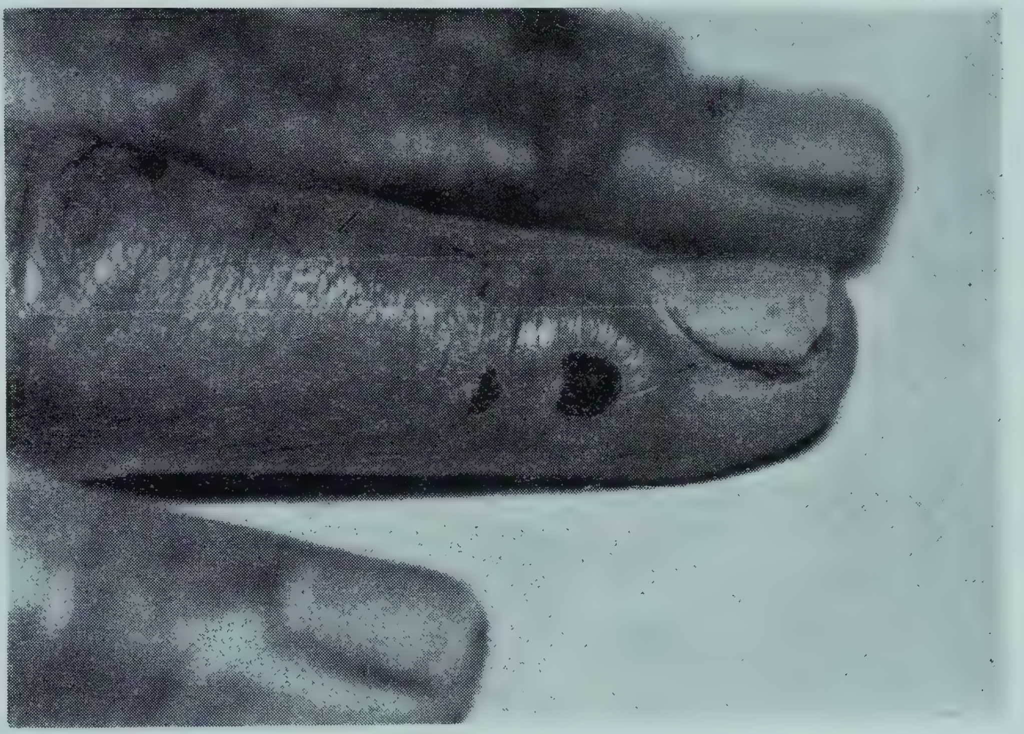


Fig. 26.—Chrome Ulcer.

Gastro-intestinal anthrax is a rarity in man. It is fatal within a few days.

Chrome Ulceration

The noxious effects of chromium compounds in industry are produced through the agency of chromic acid and the bichromates of potassium and sodium, which are largely used in the manufacture of crayons and artists' materials and in the leather, linoleum, ink, enamelling and wall paper trades. Chrome ulceration may develop on the nasal septum, being generally preceded by rhinitis and epistaxis, or on the skin. The ulcer of the septum is painless. It may perforate but, affecting the cartilage only, does not lead to disfigurement. Ulcers on the knuckles or at the roots of the nails (Fig. 26), may be painful but are not dangerous to life. The cicatrices which they leave are known as 'chrome holes.' A slight initial abrasion appears to be necessary to give ingress to the chrome.

In the dry dusty bichromate manufacture the air becomes filled with crystalline spicules, and ulcers may appear on the septum and pharynx as well as on the hands, feet and faces of workers.

In the wet chromium plating of metal fittings the articles are immersed in a plating bath of 50 per cent. chromic acid. Bubbles of hydrogen from the kathode burst at the surface of the liquid and throw a chromic acid mist up to the breathing level. Perforation of the septum may occur and also chrome dermatitis with severe itching or pain. The preventive measures are frequent cleansing of premises, local exhausts to draw off the mist, the careful dressing of abrasions, the use of ointments or rubber gloves and the wearing of masks. A protective ointment for the skin is one consisting of vaseline 3 parts and lanolin 1 part. To prevent ulceration in the nose the same ointment may be applied within the nostrils. Workers should be provided with abundant facilities for baths and ablution. Medical examinations should be frequent and thorough.

Epitheliomatous Ulceration

This lesion occurs in the manufacture of coal tar and its derivatives, the manipulation of native petroleum and the extraction of shale-oil. The original lesion is often a dermatitis or a folliculitis, followed later by a wart. Then ulcers form which in certain cases assume malignant characters. When the cancer appears on a bare surface like that of the hand or arm, it is usually the result of direct contact with the irritant compound. When it develops in a covered portion of the body it may be due to soaking of the clothes or else to fumes or fine particles suspended in the air. Thus the scrotal cancer which is a disease of gas stokers is accredited to the hot fumes of the tar. Most scrotal cancers in the shale-oil industry are among the workers at the retorts. Pitch cancer, which attends the recovery of pitch and the manufacture of briquettes from pitch and coal dust, both hot processes, attacks the face, neck and scrotum chiefly, the arms and hands less often.

Mule spinners' cancer is a hazard of the cotton trade in Lancashire. It occurs among the minders of the movable frames or 'mules' which carry the spindles. In some 80 per cent. of cases the scrotum is the area affected. The current view is that the scrotal lesion is set up by the fine spray of lubricating mineral oil launched on the air by the whirling spindles. The Tworts have found experimentally that refined textile lubricating oils are more cancer-productive than cruder oils such as those suitable for internal combustion engines.

Regular medical inspection is an essential in the control of industrial cancer, while protective clothing and barrier ointments have a certain preventive value. Investigation of carcinogenesis in relation to factory processes is a further important step in prophylaxis.

Silicosis

The dust of silica, SiO_2, sets up silicosis or silicotic pneumoconiosis. Fine particles of silica dust, 1 to 3 μ in diameter, reach the alveoli of the lung, are taken up by the pulmonary macrophages and carried away by them to the intra-pulmonary lymphoid areas. As with other pneumoconioses, the establishment of the disease depends on a number of factors including the size of the particles, the shape of their surfaces, their electrical state and the degree of atmospheric humidity. Dissolving in the cell fluids the silica stimulates the growth of fibrous tissue and so gives rise to the fibrous silicotic nodules which are characteristic of the disease. Radiography is essential to a correct diagnosis of the condition. Early signs are the broadening and deepening of the hilar shadows with a general arborisation in both lung fields. These indications, however, are not in themselves pathognomonic. The radiographic feature to which importance is attached is the development later of a diffuse mottling representing the shadows cast by the fibrous nodules. This mottling is fine at first but later on it becomes coarser and tends to be generalised, giving the 'snow-storm' effect. Still later the mottled shadows may agglomerate into large dense masses between which may be seen comparatively clear areas of emphysema. Uncomplicated silicosis may run a protracted course, and in its earlier stages may not affect the general health, though some breathlessness on exertion is usually experienced.

Tuberculosis may supervene at any stage in the course of silicosis. It is a grave complication, being a common cause of death in silicotic patients. Often there is a rapid break-down in health with loss of weight, and death ensues from haemoptysis or general asthenia. E. H. Kettle on clinical and experimental evidence held that silica had a specific influence in favouring the activities of *B. tuberculosis*. Others doubt the specific relationship, believing that the bacillus proliferates in necrotic areas of the lung. When silicosis is combined with tuberculosis the radiograph exhibits the characters of both diseases. One part of the field may show the silicotic mottling and another part reveal irregular shadowing, possibly limited to one lung or involving one side more than the other. An extensive bilateral tuberculosis may completely efface the evidence of a concomitant silicosis, in which case the clinical and industrial history of the patient may furnish clues.

The principal industrial fields in which silicosis figures are (1) metal grinding, (2) metalliferous mining, (3) the pottery trades, (4) the refractories industries, (5) sand blasting, and (6) stone quarrying and dressing. The principal forms of silica or substances containing it which are held responsible for the silicotic lesion are gritstone, quartz, flint, ganister, sand, sandstone and granite. The view, based on experience at the Broken Hill mines in New South Wales, that silicosis may be produced also by sericite, a hydrated silicate of aluminium and potassium, is in the meantime controversial.

Metal Grinding. In the grinding of metals and edge tools on gritstone wheels much silica dust is freed, against which wet grinding and hoods with local exhaust (Fig. 27) have been found protective. The racing of new gritstones is specially dust-producing. For most grinding the dangerous gritstone has now been displaced by emery, Al_2O_3, or carborundum, SiC, which are innocuous.

Metalliferous Mining. In the Witwatersrand gold mines, at which silicosis has been so closely studied, the metallic veins run in quartz rock, so that dust of quartz is freed by both the percussion drill and the subsequent blasting. Axial water feed for the drills has failed to take up the finer particles, which float like smoke about the workings and have to be trapped by special means. As regards the risk from blasting, shots are permitted to be fired only once in the 24 hours at the end of the day shift, and the dust thus produced is removed overnight by methods of ventilation before work recommences. Silicosis occurs also in the tin and copper mines of Cornwall, where quartz is the matrix, and in the metalliferous mines of Australia and New Zealand. The disease is not a normal hazard of coal mining.

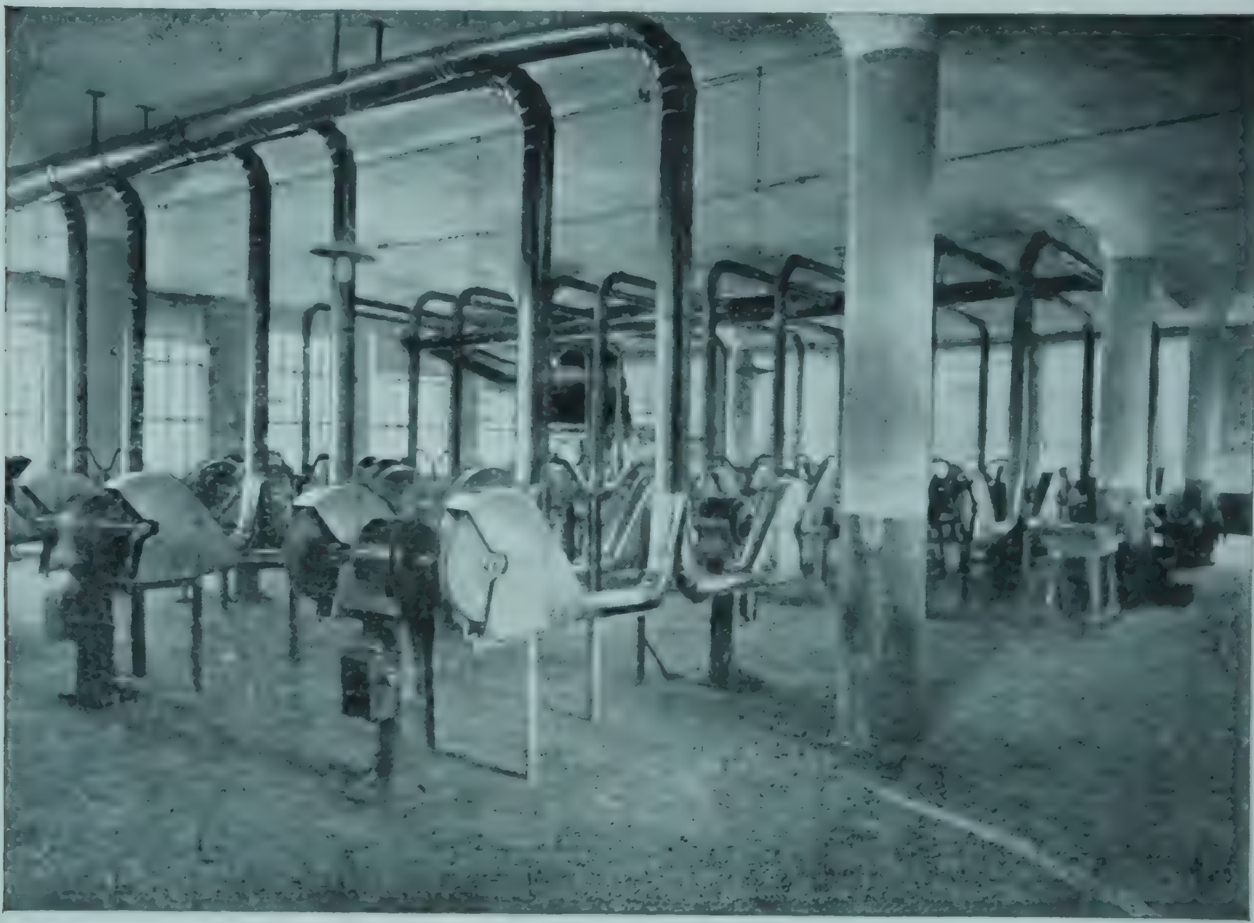


Fig. 27.—Local Exhaust in Grinding Shop.

Pottery Trades. In these trades siliceous dust is freed in forming the ware, and the 'biscuit' ware for firing is bedded in flint dust which is inhaled by the placers and bedders. There is danger also to those who scour the ware after firing by brush or sand blast to remove the dust. It is protective to enclose the machines or use exhaust ventilation. In the ancillary process of flint grinding a water spray may be employed.

Refractories Industries. Refractory materials, of which ganister is an example, are mined or quarried, broken, crushed, ground and calcined for use in the manufacture of heat-resisting bricks or mouldings required by the steel trades. Every step in the procedure liberates dust of silica.

Precautionary measures prescribed by regulation are work in the open air, enclosure of machines, exhaust draughts, steam or water sprays, damp methods and the wearing of respirators by workers.

Sand Blasting. A high fatality rate from silicosis with or without tuberculosis attends the use of the sand blast for cleansing the surface of metal castings or cutting designs on glass. The blast is obtained from compressed air at 30 to 100 lbs. per square inch. A recent advance has been the introduction of steel shot or non-siliceous abrasives, including alundum, instead of sand, but even so sand is still present in the air, being blown off the castings by the force of the blast.

Stone Quarrying and Dressing. Masons and stone dressers or cutters are prone to silicosis with or without tuberculosis if the material on which they work contains free silica. Granite is a mixture of quartz, mica and felspar. Sandstone may contain 98 per cent. of silica in a matrix of calcium carbonate. In dressers of these stones the phthisis mortality rate is double that of workers with limestone, which is silica-free. The best protection for the workers is a pneumatically operated tool, the air discharged from which blows the dust into a collecting hood fitted to a vigorous exhaust. The dust so withdrawn is caught in a trap of closely woven fibre which arrests all particles both coarse and fine.

Talc Industries. Talc is the acid-resistant silicate of magnesium. It is extensively employed in the perfumery and cosmetic trades, in the manufacture of cardboard, in the fabrication of acetylene and other gas jets and in the making of sealing wax. Inhalation of powdered talc may lead to pulmonary fibrosis, though radiological evidence of true silicosis is wanting. The dust has been accused also of producing gastric achylia.

Asbestosis

Commercial asbestos includes a number of fibrous silicates, mainly of magnesium or iron. They are fire- and acid-resisting. If the fibres are long and flexible they can be spun and woven. Fibres which cannot be spun are made up in many forms such as asbestos tiles or millboard, or used for the brake linings and clutch rings of motor cars. A fine dust of asbestos is freed in the crushing and opening out of the crude mineral, in carding the fibre and in weaving or otherwise forming the finished article.

The inhalation of asbestos dust gives rise to asbestosis which is a finely reticular fibrosis of the lung. Early signs are shortness of breath combined with a diffuse bilateral impairment of the percussion note especially at the back of the chest. The radiographic picture exhibits a ground-glass appearance or veiling with fine pinhead stippling. In late stages this stippling may become less fine but it is never so pronounced as the mottling of silicosis. As fibrosis increases the lung function is progressively impaired. Intermittent attacks of dry pleurisy occur and death may result from a low-grade bronchopneumonia or from bronchitis. Tuberculosis also may induce a fatal issue, but less frequently than in silicosis. Asbestosis on the other hand incapacitates more quickly. In a recent series of fatal cases the duration of employment was twice as long for silicosis as for asbestosis.

Post-mortem in fatal cases of asbestosis the elongated 'asbestosis bodies' are found in and around the alveolar spaces of the lung. They have a golden yellow colour and may measure up to 100 μ in length. They consist of a sagittally disposed asbestos fibre embedded in a colloidal organic aggregate which sometimes reacts to the tests for iron. Some of the bodies are clubbed at one end or both. Others are more filamentous, while others again show as a series of beads. They are not pathognomonic of the existence of asbestosis but are evidence of exposure to asbestos dust.

The protective measures against asbestos dust prescribed by regulation include localised exhaust ventilation, enclosure of machines, use of wet methods, efficient cleansing and, for certain processes, the provision of breathing apparatus.

The need for regular medical inspection, including serial x-ray photography of the chest, can scarcely be over-estimated in the case of all who are exposed to the risk of pneumoconiosis.

Other Dust Effects

The gravest results of exposure to dust in industry are those produced by arsenic, lead, manganese, chromium, the anthrax bacillus, silica and asbestos, which have already been noted. Other dusts than these, though usually less dangerous to life, occasion disability from time to time. Dust proceeding from silk, leather or horn may lead to respiratory catarrh. In the past the use of South African boxwood in shuttle-making set up cardiac asthma. In textile processes such as cotton carding and flax heckling, and in the shoddy and flock manufacture, the dusts freed may induce in those encountering them for the first time, or after an interval, a transient bronchitic or asthmatic affection. Prolonged exposure in the case of certain cotton operatives may result in permanent 'byssinosis' with diminished chest expansion and emphysema. Localised outbreaks among cotton weavers of paroxysmal cough with scanty sputum and a feeling of obstruction in breathing are ascribed to moulds present in the warp. Inhalation of pigmented dusts, such as ultramarine, steatite and haematite, leads in time to pulmonary chromatism. Jute dust may carry tetanus bacilli. The dusts of quicklime and cement, being highly hygroscopic, may cause cough, skin ulceration and perforation of the nasal septum. Dust from marble, limestone or gypsum appears to be innocuous. Pneumomycosis may arise in maltsters from inhalation of mycelia from the grain in storehouses, while acarus infestation of the lungs of florists has been derived from vegetable dust. The term *Bagassosis* is now applied to a fibrotic condition of the lung which is due to the inhalation of dust from bagasse, the residue of crushed sugar cane. This substance, which seems to carry a sensitising element, is employed in the manufacture of insulating board.

Dermatosis

Some 30,000 cases of occupational dermatitis are believed to occur annually in Great Britain, the lesions ranging in a wide variety of trades from erythema to epithelioma. Dermatitis is the commonest of the industrial disabilities, and accounts for upwards of 70 per cent. of compensable occupational disease. The dermatoses depend partly on the action of an irritant, the primary causative factor, and partly on the degree of reaction of the skin, the accessory factor. While in most instances they result from irritation of the skin surface, cases are known in which the noxious substance passes unchanged through the integument and exerts its influence from beneath. Though a rational classification of industrial dermatopathic factors is scarcely possible, the generally accepted broad grouping of causes is (1) mechanical and physical irritation by friction, heat or cold, (2) detergent action by hot water, alkali, turpentine or the like, (3) desiccation by strong acids or anhydrides, (4) precipitation of skin proteins by heavy metallic salts, (5) keratogenic and carcinogenic action by tar derivatives, or oils, (6) irritation by biotic agents, including bacteria, fungi and animal parasites and (7) allergic states giving rise to antigenic reactions.

Personal resistance to dermatosis alters from time to time. It is to some extent governed by age, sex and nerve conditions. Young workers for example are more prone to acute forms than are the middle-aged. Those who already suffer from eczema, seborrhoea or chilblains, as also those who perspire freely, are especially liable to occupational rashes. The latent period between the exposure to risk and the onset of a dermatosis is not constant and may, as in the case of arsenic, be of many years' duration. When the provocative is solid or liquid it acts in general more quickly than when in the form of dust or fumes. Most lesions begin with erythema, due to defensive vascularity, and are at this stage readily curable. Later, bacterial infection occurs and the condition may become intractable. In some cases the dermatopathic substance exhibits a selective action. The invasion of the sudoriparous and sebaceous glands by lubricating oils produces acneiform folliculitis, the 'oil dermatitis' of the engineering trades (Fig. 28).

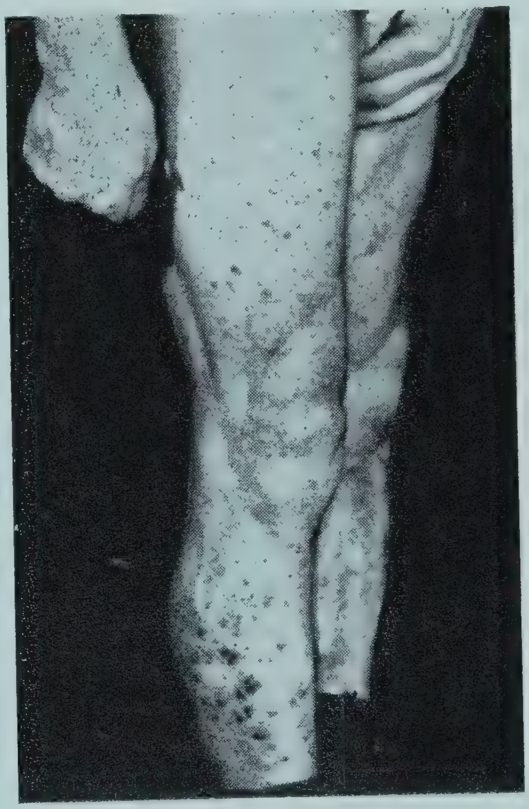


Fig. 28.—Oil Dermatitis.

The hands, being frequently washed, are free of the eruption.

As examples of industrial dermatoses there may be cited the eczema of french polishers, the aniline eruption of dyers, the urticaria of gardeners, the teak and birch erythemas of sawyers, the fulminate itch of explosives operatives, the shagreen skin of tar workers and the metol rash of photographers. Amongst conditions due to parasitic agencies are the *mal des cannes* of Provence, a dermatomycosis due to a fungus of the mucor group, the chicken-mite eruption of poultry farmers, the harvest itch due to *Leptus autumnalis*[1] and the erythema of dockers who handle mite-infested copra. The onychomycosis of brewers, caused by a hyphomycete, and the ungual erosion found in the bleaching, dyeing and straw-plaiting trades are kindred to the occupational dermatoses. Cases of dermal super-sensitivity are recorded from time to time (Fig. 29). An immediate change of occupation should be the rule in such instances.

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[1] Page 569.

The skins which offer the best resistance to irritants are those which feel thick when raised between the finger and thumb, which are not too dry and which are free of blemishes. An employer carrying on a process in which dermatitis is prone to occur should select as new workers those whose skins conform to the above description. Systematic inspection of the hands of workers should be made, and early lesions treated and covered. Care must be taken to distinguish occupational dermatoses from specific skin affections such as seborrhoea, pityriasis and the like. The aid of a skilled dermatologist may be required in this connection. If the industrial process does not permit of effective covering of the

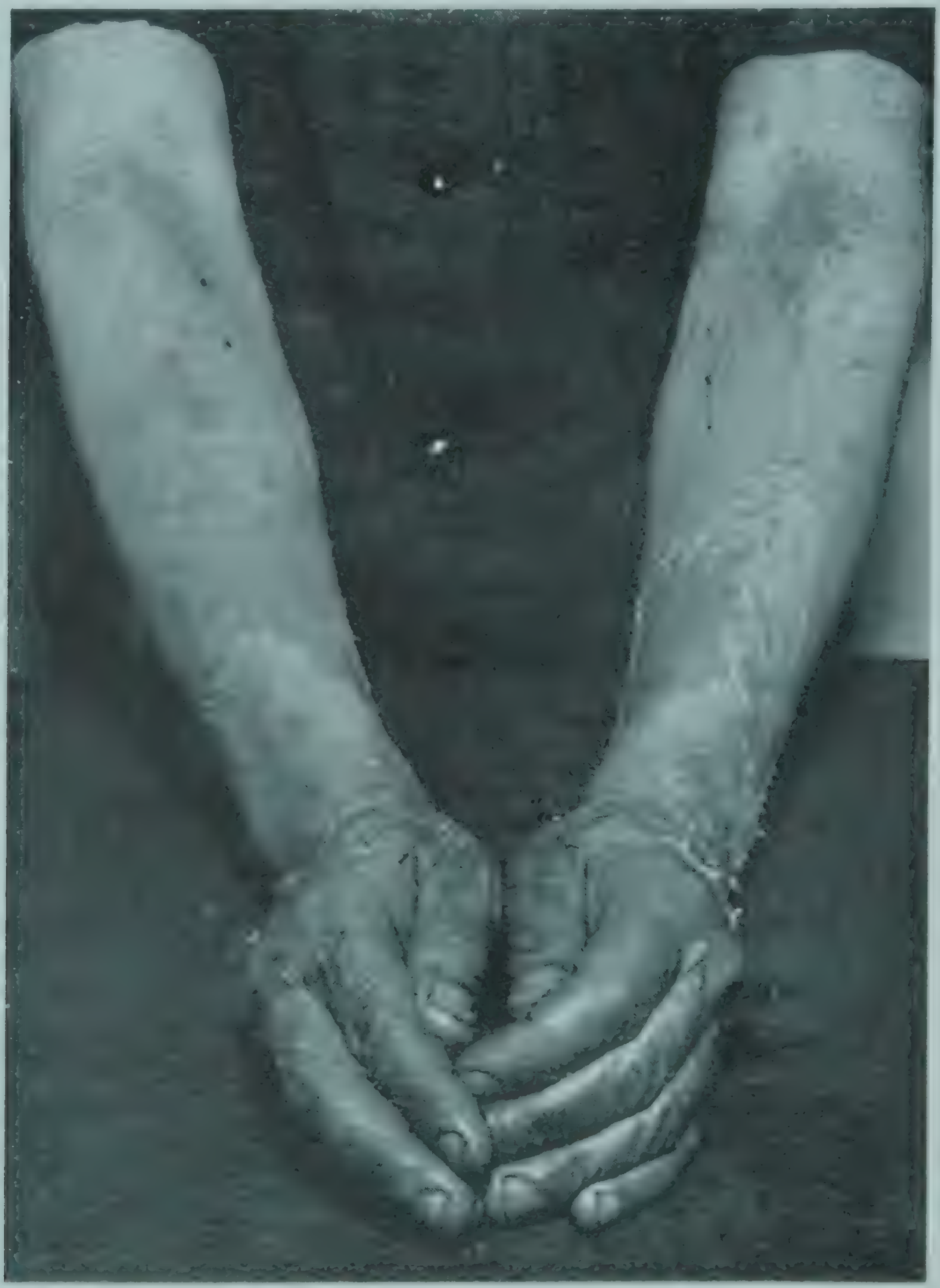

Fig. 29.—Paraffin Dermatitis.

The extensive lesions developed within two days of contact with paraffin oil part, transference to other work, at least for a time, is the proper course. Gloves should be used where necessary and every washing facility provided.

Much may be done to combat the dermatoses by the use of 'barrier' protective creams, which are of six main classes. Stearic-carbonate creams, which fill the pores with soap: tragacanth-acacia ointments, which leave upon the skin a water-insoluble resin—the 'invisible glove': lanolin base creams, which coat the skin and fill its pores with neutral fat: detoxicating ointments, which contain a non-irritant chemical to neutralise the effect on the industrial dermatopath: inert powder creams, which deposit a protective dust from an ointment base. It is now possible to demonstrate the presence of the supersensitive state in operatives by means of the patch test, which consists in applying to an area of normal skin a small amount of the suspect substance either solid or in solution for a period of some hours. The occurrence of a dermatitis reaction at the patch site suggests supersensitiveness to the substance under test. Some experience in the interpretation of the tests is required. Workers who prove to be supersensitive should be excluded from the trade concerned. Cases of true allergy also occur amongst industrial workers.

Caisson Disease

The caisson employed in laying foundations under water, as for bridges over rivers, is a water-tight steel or iron cylinder, open below like a bell, and with a free cutting edge by means of which it sinks into the ground as the earth inside is removed. Air is driven into the cylinder from above and forces its way out below through the bed of the river, so that the working surface is kept clear of water. The pressure may range from a few pounds above normal up to an atmosphere or two. The added pressure is one atmosphere for every 33 feet of submersion. Access to the caisson is gained by workmen through an air lock with two air-tight doors, one opening to the outer air, the other into the caisson.

During compression in the air lock with a view to entering the caisson there may be discomfort or pain in the ear through the forcing-in of the membrana tympani. To relieve the pain, pressure on the drum head may be equalised by inflating the Eustachian tube. Or else the worker, like the aviator when diving, may be instructed to chew gum. Decompression with a view to egress should normally be carried out at the rate of 3 lbs. in 1 minute. If the rate is too rapid caisson disease may develop. The evidences of the condition range in severity from vertigo, nausea, vomiting and the painful 'bends' or 'screws' to paralysis, dyspnoea, convulsions, coma and death. These manifestations are caused by the liberation from the blood of excess dissolved nitrogen, the minute bubbles of which coalesce to form gas emboli cutting off the blood supply of the part affected. An attack should be treated by recompression, preferably in a warmed medical air lock, followed by slow decompression at the rate of 1 lb. in 3 minutes.

Aids to the prevention of caisson disease are short shifts of work, especially at high pressures, cooling the cylinder of the compressor engine to withdraw heat from the compressed air entering, and the use of electric light within the caisson. Operatives should be fit men of temperate habit aged between 20 and 30. A man suffering from nasal catarrh or sore throat should be excluded from caisson work till he recovers.

Deep Sea Diving

Admiralty divers wearing rubber diving suits can nowadays work safely at depths of 50 fathoms and over, where pressures are of the order of 10 atmospheres. Under former conditions a slow enough decompression after such spells would have required the diver to allow about 2 hours for his return to the surface, holding the while to a rope and exposed to the force of the tides and the cold of the sea. The use now of the Davis Submersible Decompression Chamber has shortened the time by as much as one-half. This chamber, which is of steel, is equipped with an oxygen breathing apparatus and can be lowered to pick up the diver at any depth desired. In an emergency it can convey him immediately to the surface.

With the all-metal diving dress greater depths can be attained than with rubber suits, but the metal outfit is cumbrous and too slow in its operations to be of service, for example, to a disabled submarine.

Oxygen breathing has been of great service to deep sea diving. It speeds up the elimination of nitrogen by the lung and feels refreshing to the divers when they enter the Davis chamber. Two to three atmospheres of the gas can be borne. At higher pressures convulsions impend. A former concomitant of deep diving was the laboured breathing of divers occasioned by increased absolute pressure of carbon dioxide. This difficulty has been overcome by means of a canister containing a carbon dioxide absorbent which now forms part of the deep diving equipment.

Not all men are suited to become deep sea divers. So far as physique is concerned moderately adipose athletic types are to be preferred. By their fat they are protected against the cold of the water, and their muscle enables them to endure the arduous work and hard knocks which are their portion. As it is dark in the depths a sound labyrinthine system is essential with a view to balance. The diver's psychological make-up is equally important. He should possess a steadfast mind and have control of his imagination. Any suggestion of claustrophobia should disqualify.

NOTIFIABLE INDUSTRIAL DISEASES

In terms of the Factories Act, 1937, every medical practitioner attending or called in to visit a patient, whom he believes to be suffering from a specified disease which has been contracted in any factory, must forthwith send to 'The Chief Inspector of Factories, Ministry of Labour and National Service, London' a notice stating the name and full postal address of the patient and the disease from which, in the opinion of the medical practitioner, the patient is suffering, and the name and address of the factory in which he is or was last employed.

The doctor's fee for notifying is 2s. 6d. The penalty for failing to notify is up to 40s. Certain further industrial diseases have been added to the list by Order. Lead poisoning contracted in painting buildings is notifiable under a special Act as if contracted in a factory. The complete list of the industrial diseases due to be notified by practitioners is as shown hereunder:

Lead Poisoning.
Phosphorus Poisoning.
Arsenical Poisoning.
Mercurial Poisoning.
Anthrax.
Toxic Jaundice.
Epitheliomatous Ulceration.
Chrome Ulceration.
Carbon Bisulphide Poisoning.
Aniline Poisoning.
Chronic Benzene Poisoning.
Manganese Poisoning.
Caisson Disease.
Toxic Anaemia.

The purpose of notification is to enable the Factory Department to cause any faults of plant or working to be corrected with a view to preventing further cases of the disease.

EXAMINING SURGEON

Medical practitioners are eligible to hold the position of Examining Surgeon under the Factories Act. Appointments are made, according to the directions of the Minister, by either the Chief Inspector of Factories or the superintending inspector of the division within which the area to be served is situated. Remuneration is by fee.

The principal duties of the Examining Surgeon are to examine and certify young persons as to their fitness for employment: to examine and report upon cases of death or injury caused by exposure in a factory to fumes or other noxious substances referred to him by the district factory inspector: to examine and report upon any cases of disease of which he receives notice under the Factories Act: to make such special enquiry and examination of employed persons as may be directed and to make an Annual Report upon his work in the prescribed form. It is his duty also to examine and certify for the purposes of workmen's compensation.

A notice stating the name and address of the Examining Surgeon is required to be displayed in all factories.

MINES

Mines of coal, stratified ironstone, shale and fireclay are regulated under the Coal Mines Act, 1911: other mines under the Metalliferous Mines Acts, 1872-75: and quarries under the Quarries Act, 1894.

The ventilation of coal mines is usually on the exhaust system by means of centrifugal fans at the head of the upcast shaft. In the levels the entering and outgoing air currents are kept in separate channels, and the air is guided to the working face by means of canvas brattices.

The mine gases or 'damps' are mainly three. 'Fire damp' is methane, CH_4, with some ethane, C_2H_6, on occasion. In a proportion of 5 to 13 per cent. it forms an explosive mixture with air. 'Black damp' contains excess CO_2 attended by a corresponding deficiency of oxygen. The fatalities which it causes are due to oxygen shortage. The 'after damp' which follows on explosions of fire damp owes its deadly properties to carbonic oxide, CO, which does not, like both fire damp and black damp, affect the flame of the safety lamp. A mouse, sparrow, or canary in a cage may be used to warn rescue parties. There is danger in air containing more than 0·2 per cent. of CO. Hydrogen sulphide may be liberated in mines as a result of the decomposition of iron pyrites. One part in 7 of air forms an explosive mixture.

Miners' Nystagmus, which is the outstanding occupational disease of coal miners, is an involuntary oscillation of the eyes, sometimes preceded by photophobia, resulting from visual fatigue. It goes with the use of the safety lamp and does not occur in metalliferous mines where naked lights are used. Owing to the unrelieved blackness of the coal face in the light of the safety lamp the eye becomes dark-adapted. In this state the light-sensitivity of the peripheral parts of the retinal field is increased while that of the macular region is for practical purposes unchanged. The peripheral parts are therefore used and, as they easily tire, one peripheral area after another is brought into service by moving the eyes. In the end the ocular muscles make the necessary movements involuntarily. Contributory factors are malposition of the worker, continuous upward glancing at the coal face, labyrinthine irritation and defective nutrition. Some 30 per cent. of miners working in dim light may exhibit this type of nystagmus without suffering disability. Others begin to see badly, missing their aim with the pick, and sooner or later develop neurasthenic symptoms, including blepharospasm, spasmodic torticollis, sleeplessness, a characteristic occipital headache, vertigo, amnesia and psychoneurosis. As there is no structural eye lesion the timely removal of the man from underground work will usually cure his oscillations in a few weeks or months. His neurotic condition is more intractable and may require psychotheraphy. It tends to be prolonged by the payment of workmen's compensation, and the Miners' Nystagmus Committee have expressed the view that the correct treatment for such cases is to provide work of some kind with the object of restoring the patient to full underground duty in a good light. The illumination required can be obtained from a 2-volt electric lamp worn in the miner's cap, or from a lamp of 4 candle-power within 4 feet of the coal face.

A frequent affliction of the coal winner is cellulitis. When he works kneeling he may acquire subcutaneous cellulitis or acute bursitis about the knee-joint, known as 'beat knee.' When he works lying on his side his elbow may be similarly affected, the lesion being known as 'beat elbow.' In using the pick he may contract 'beat hand,' an infective state of the palm, or tenosynovitis of the wrist, which is non-infective. Posture intertrigos of the groin and axilla are also of frequent occurrence. Other dermatoses of the miner include 'water itch' from damp, creosote eczema from contact with pit props and furunculosis engendered by coal dust. Knee pads, smooth pick handles and cleanliness of the skin are protective against these conditions, which are fertile causes of incapacity for work.

Silicosis, as already noted, is not a normal hazard of coal mining, but it may develop in coal miners mainly employed on hard heading work in the course of which they have to apply the pneumatic drill to sandstone rock.

Anthracosis is a phase or a sequela. Inhaled coal dust, in the absence of mineral dust, may blacken the miner's lung without impairing function. A Committee appointed by the Medical Research Council, examining a series of cases, found no evidence that anthracite or other coal dust had caused fibrosis. If however coal dust is inhaled into a lung which is already silicotic the dust may accumulate in the lung in damaging quantity. The condition so resulting is sometimes called anthracosis. It may terminate in a fatal bronchitis or similar affection.

Ankylostomiasis in England has been limited to the Cornish tin mines, in which it was prevalent during the early years of this century. The miners were frequently infected by way of their arms, where the embryos raised the painful 'bumps' or 'bunches.' The Levant mine near St. Just, the water in which was brackish as the workings stretched below the sea, remained free of infection.

Weil's Disease, or Infective Jaundice, appeared in collieries at Tranent in Scotland in 1923, producing fourteen cases. All but one, an agricultural worker, were employed in the pits.

Welfare Schemes for collieries are financed from the Miners' Welfare Fund which is maintained by a levy of one penny per ton of coal raised. Among the provisions made are institutes and welfare halls, recreation grounds, hospitals, convalescent homes and educational facilities. At the pit-head baths, which form a special feature, douches are installed and lockers arranged for drying clothes. A canteen also is often attached for the supply of light refreshments.

WORKMEN'S COMPENSATION

The object of the Workmen's Compensation Acts, 1925-1945, is to make provision for employees disabled through injury arising out of and in course of their employment or, if the injury results in death, for any person who was dependent on the deceased. To effect this object the employer is made liable to pay compensation for such injuries. The injuries for which compensation is payable are (1) injury by accident and (2) injury to health by scheduled industrial diseases.

The industrial diseases scheduled by Act or Order are the following:

Anthrax.

Poisoning by mercury, phosphorus, arsenic, lead.

Poisoning by benzene and its homologues, nitrobenzene with trinitrotoluene and aniline and any other nitro- or amido-derivative of benzene and its homologues.

Poisoning by dinitrophenol, nitrous fumes, dope, tetrachlorethane, carbon bisulphide, nickel carbonyl, African boxwood and manganese.

Dermatitis or ulceration produced by dust or liquids: epitheliomatous ulceration, and corneal ulceration due to tar and kindred substances: chrome ulceration: scrotal epithelioma.

Compressed air illness. Caisson Disease.

Cataract in glass workers: cataract caused by rays from molten metal.

In mining, ankylostomiasis, miners' nystagmus, beat hand, beat knee, beat elbow and tenosynovitis of the wrist.

Glanders.

Telegraphist's cramp: writer's cramp and, in the cotton and woollen trades, twister's cramp.

Injury due to exposure to radio-active substances.

New growth of skin, papillomatous or keratotic, due to mineral oil.

Poisoning by diethylene dioxide (dioxan).

Poisoning by chlorinated naphthalene.

Poisoning by tri-o-cresyl phosphate: triphenyl phosphate.

Poisoning by methyl bromide.

Infection by Leptospira icterohaemorrhagiae confirmed by bacteriological or serological examination.

A workman is in a position to claim compensation if the examining surgeon has issued a certificate bearing that he is suffering from one of the scheduled diseases and is thereby disabled from earning full wages at the work on which he was employed, or if he is suspended from his usual employment on account of having contracted a scheduled disease. If a workman is aggrieved by the action of the examining surgeon in refusing him a certificate of disablement the question is referred, in terms of the pertinent regulations, to a medical referee, whose decision is final. Similarly if an employer is aggrieved by the action of the examining surgeon in issuing a certificate of disablement, the medical referee will decide between the parties.

No compensation is due to be paid if the workman at the time of entering the employment wilfully and falsely represented himself in writing as not having previously suffered from the disease.

For the purposes of the Acts a workman is any person who has entered into or works under a contract of service or apprenticeship with an employer, whether by way of manual labour, clerical work or otherwise, and whether the contract is expressed or implied, is oral or in writing. Non-manual workers whose remuneration exceeds £420 a year are, however, excluded, as are also casual workers, all persons employed otherwise than for the purposes of the employer's trade or business, members of a police force, and those undertaking work as independent contractors.

For the industrial diseases associated with certain trades, compensation may be effected through special schemes. Examples are the Refractories Industries (Silicosis) Scheme, 1931: the Sandstone Industry (Silicosis) Scheme, 1931, and Amended Scheme, 1946: the Metal Grinding Industries (Silicosis) Scheme, 1931, and Amended Scheme, 1946: the Various Industries (Silicosis) Scheme, 1931, and Amended Schemes, 1935 and 1946: the Shipping Industry (Pneumoconiosis) Compensation Scheme, 1946: the Asbestos Industry (Asbestosis) Scheme, 1931, and Amendment Scheme, 1946: and the Coal Mining Industry (Pneumoconiosis) Compensation Scheme, 1943.

Silicosis and Asbestosis. In terms of the Silicosis and Asbestosis (Medical Arrangements) Scheme, 1931, and Amended Schemes, 1939 and 1946, the medical examinations of workers in processes involving risk from silica or asbestos are under the charge of the Silicosis and Asbestosis Medical Board. Entrants must be examined within 2 months of commencing employment not by the examining surgeon but by either a member of the Board or a medical practitioner appointed for the purpose. They are rejected if they exhibit inadequate chest development, if they suffer from any disease of the heart or lungs or if they show evidences of tuberculosis in any organ. Workers in certain processes are required to undergo subsequent periodical examinations. Any operative suffering in a dangerous degree from tuberculosis, silicosis or asbestosis is due to be suspended. The compensation of workers for injury to health by silica or asbestos is administered not under the usual procedure of the Acts but in terms of special compensation schemes which have been established for the refractories, metal grinding and other industries. Claimants are due to be examined not by the examining surgeon but by the Silicosis and Asbestosis Medical Board, whose decision is final. In the case of a death claim the certificate of the Board can only be given after post-mortem examination, unless the worker at the time of his death was receiving weekly payments under a compensation scheme.

Byssinosis. Compensation in respect of male cotton trade workers who have died or been totally and permanently incapacitated as the result of byssinosis or card room workers' asthma is provided for by the Workmen's Compensation and Benefit (Byssinosis) Act of 1940. The Byssinosis (Benefit) Scheme, 1941, made under the Act, requires that the worker must be certified to have been employed for not less than twenty years in the aggregate in cotton card rooms or other specified places where they spin raw cotton.

Occupational hazards of the professions include the palsy of writers and scriveners scheduled as writer's cramp, the kneading cramp of sculptors, the callosities of violinists, the teno-synovitis of acrobatic dancers, the kerato-conjunctivitis and kleig lamp fatigue of motion picture artistes, the temperamental neuroses of actors, the emphysema of cornetists and others, and the eye-strain of theatre musicians.

The existing scheme of Workmen's Compensation is due to be superseded by the National Insurance (Industrial Injuries) Act, 1946, but the change over is not expected before 1948.

VII.

PUBLIC HEALTH ADMINISTRATION

PUBLIC Health is administered in England and Wales under the general superintendence of the Minister of Health, whose Department is the Ministry of Health with offices in London. Local health is managed by local authorities, which are bodies popularly elected for local government purposes including public health.

MINISTER OF HEALTH

It is the duty of the Minister to concern himself with measures conducive to the health of the people, such as the prevention and cure of disease, the treatment of physical and mental defects, the care of the blind, the direction of research, the collection of statistics and the training of health services personnel. Other powers and duties which have devolved upon him comprise medical benefit, poor relief, public vaccination, registration and public health generally, together with infant life protection and the care of expectant and nursing mothers and children under school age. A Board of Health under the Minister is authorised for Wales.

Besides the Ministry of Health there are other central departments in London which exercise authority in various ways for purposes related to health. The title and functions of each are noted in Table 2.

LOCAL AUTHORITIES

For health administration in England and Wales the country is divided into counties, county boroughs, municipal boroughs and urban and rural districts. The local authorities are the councils of these areas. Councils of counties and county boroughs are principal authorities. Councils of municipal boroughs and of urban and rural districts are subordinate to their respective county councils.

County Councils discharge duties which are in part supervisory and in part executive. Their supervisory duties relate to general sanitation and other services conducted by the councils of their subordinate municipal boroughs and urban and rural districts. In their executive capacity they administer the Midwives Acts, tuberculosis, venereal disease, public assistance, mental deficiency, the destruction of rats and mice and rivers pollution prevention, and they may in certain cases deal with maternity and child welfare and food and drugs.

County Borough Councils, which are independent of county councils, have charge of all public health activities within their own boundaries.

Municipal Borough Councils are concerned with general sanitation and such other services as are not required to be administered by the county council direct.

Urban District Councils have duties akin to those of municipal borough councils, from whom they differ more in status than in function.

Rural District Councils have in general a narrower range.

TABLE 2.

CENTRAL DEPARTMENTS

England and Wales

DEPARTMENTS.	FUNCTIONS.
Ministry of Health .	The Health of the People.
Registrar General . .	Registration. Census. Vital Statistics
Ministry of Education .	Instruction in Hygiene. Physical Education. Medical Inspection and Treatment.
Ministry of National Insurance . . .	National Insurance.
Ministry of Labour and National Service .	Factory Department. Factories and Industrial Health.
Ministry of Town and Country Planning .	Town and Country Planning.
Board of Control . .	Mental Deficiency and Lunacy.
Central Midwives Board	Training, Enrolment and Supervision of Midwives.
General Nursing Council	Training and Registration of Nurses.
Ministry of Agriculture and Fisheries . .	Agriculture, Fisheries and Diseases of Animals.
Board of Trade . .	Health and Welfare of Merchant Seamen.
Ministry of Fuel and Power . . .	Safety and Welfare of Miners.
General Medical Council	Medical Education and Registration.
Dental Board of the United Kingdom .	Dental Training and Registration.

LEGISLATION

Local authorities derive their powers from Acts of Parliament, which may apply to all the United Kingdom or to England and Wales alone or to Scotland alone. Such Acts are general Acts but there are also local or private Acts which affect a particular area only. Adoptive Acts are Acts which do not come into operation until they have been adopted by the local authority concerned.

The range of a general Act is inevitably wide, too wide in many cases to permit of a detailed exposition of the minutiae of administration. To anticipate this difficulty an Act may be so framed as to grant power to a Minister to take appropriate steps.

The Minister may then make 'Regulations' prescribing courses of procedure. Such regulations will be laid before Parliament if Parliament so desires. A 'Provisional Order,' which requires the confirmation of Parliament, may be made by a Minister or a local authority with regard to some specified interest such as the Sale of Milk.

'Byelaws' rank high as administrative instruments. They have been defined as 'law made with due legal obligation by some authority less than the Sovereign and Parliament in respect of a matter specially or implicitly referred to the authority and not provided for by the general law.' Subjects for byelaws have been Baths and Washhouses, Cemeteries, Common Lodging Houses, Houses let in Lodgings, Markets, Mortuaries, New Streets and Buildings, Nursing Homes, Offensive Trades, Public Conveniences, Scavenging, Slaughter Houses, Smoke Abatement, and Tents, Vans and Sheds.

The series of 'Model Byelaws' issued by the Ministry of Health has proved a valuable guide to local authorities.

Public Health Administration for England and Wales is largely set forth in the Public Health Act, 1936, which consolidates and amends previous health legislation back to the Public Health Act of 1875. It repeals some 28 Acts in their entirety, together with portions of many more, but preserves what is useful and at the same time shapes it to conformity with present-day requirements. The Act, which is made up of 12 parts, is hereunder presented.

PUBLIC HEALTH ACT, 1936

PART I

Local Administration

1. **Local Authorities.** It shall be the duty of the following authorities to carry this Act into execution: in a county borough the council of the borough: in an administrative county the county council, and as respects all other matters the councils of county districts.

'Local authority' means the council of a borough, urban district or rural district.

2. **Port Health Authorities.** In this Part of the Act 'port' means a Customs port. The expression 'riparian authority' means any local authority whose district or any part of whose district forms part of, or abuts on, that port or part of a port, and any conservators, commissioners or other persons having authority over that port or part of a port. The Minister may constitute a port health district, and one or two or more riparian authorities forming a joint board.

An Order constituting a port health district shall confer on the port health authority jurisdiction over all waters to which the Order relates, and also over the district of such riparian authority as may be specified. The Order may further assign to port authorities any of the functions, rights and liabilities of a local authority.

A local authority having jurisdiction in any part of a port health district, including London, shall cease to discharge in relation thereto any functions which are functions of the port health authority.

Port sanitary districts and port sanitary authorities constituted under any Act passed before this Act, including London, shall be known as and styled 'port health districts' and 'port health authorities.'

6. **Joint Boards.** If on an application made to him by local authorities of districts it appears to the Minister that it would be to the advantage of these districts to be united, the Minister may by order constitute them a united district. The governing authority of a united district shall be a joint board.

When the Minister proposes to make an order as above he shall give notice to the local authorities of the districts concerned, and if within 28 days they give notice that they object, the order made by the Minister shall be provisional only, and shall not have effect until confirmed by Parliament.

11. **Division of Districts.** An urban authority may divide their district into parts for all or any of the purposes of this Act. A rural authority may, with the approval of the Minister, constitute any part of their district a 'special purposes area' for the purpose of charging thereon exclusively the expenses of works of sewerage, sewage disposal or water supply, or any other works the expenses of which are declared by enactment to be special expenses.

13. **Rural Authorities.** The Minister, on application, may invest a particular rural district with urban power. This application may be made by the rural district council, or the county council or the parish council or a specified number of local government electors for the district.

PART II

Sanitation and Buildings

14. **Sewerage and Sewage Disposal.** Every local authority must provide the sewers necessary for their district and, by means of sewage disposal works or otherwise, deal effectively with the contents of their sewers. They may construct within their district sewers under streets or, after notice given, in land which is not a street. They may build sewage disposal works on land appropriated for the purpose. In certain cases it may suffice to contract for the right to use a sewer or disposal plant.

If the construction of sewers and sewage disposal works is to be outside of their district the local authority must publish in a local newspaper a notice of their proposals, specifying the land concerned. If owners or occupiers of land give notice of objection, then unless all such notices have been withdrawn, or the Minister after a local enquiry has expressed his approval, the local authority cannot proceed.

A local authority may agree with any person constructing or proposing to construct a sewer, drain or sewage disposal works that on the completion of the work they will declare the sewer, drain or works to be vested in them. A similar agreement cannot be made if the sewer, drain or works are in the district of another local authority unless that other local authority has consented or the Minister, when applied to, has dispensed with the need for such consent.

19. Where a person preposes to construct a drain or sewer the local authority, if they consider that the proposed drain or sewer is likely to form part of a general sewage system, may require the person to construct the drain or sewer in a manner different from what he had intended. It is the duty of the person to comply with this requirement. He has however the right of appeal to the Minister, and he is entitled to repayment by the local authority of any extra expenses reasonably incurred by him.

Agreement may be made by a local authority with the county council for the use of highway drains for sanitary purposes, or by the county council with a local authority for the use of public sewers vested in the local authority for the drainage of highways. Neither party shall unreasonably press or reject any terms offered.

Local authorities are empowered to alter or close any public sewer vested in them provided that they lay down another as effective. It is the duty of every local authority to maintain, cleanse and empty all public sewers vested in them, recovering expenses in certain cases.

25. Where the plans for a building or extension of a building reveal that it is proposed to erect the building or extension over any sewer or drain shown on the official map, the local authority shall reject the plans unless they are satisfied that they may properly consent to the proposed erection.

27. A local authority shall afford what facilities they can for factories to drain into the public sewers. It is forbidden to throw or empty into a drain or sewer (1) any matter likely to injure it or impair its flow, (2) chemical refuse, waste steam or any liquid above 110° F. and (3) petroleum derivatives especially those having a flash point below 73° F.

Nothing in this Part of the Act shall authorise a local authority to construct or use any sewer or drain or outfall for the purpose of conveying foul water into any natural or artificial stream, watercourse, canal, pond or lake until the foul water has been purified.

34. **Private Sewers and Drains.** The owner or occupier of any premises, or the owner of any private sewers within the district of a local authority, is in general entitled to have his drains or private sewer made to communicate with the public sewers and thereby to discharge foul water and surface water from these premises or that private sewer. Nothing however in this section shall entitle any person to discharge into any public sewer any liquid from a manufacturing process or any liquid prohibited under any enactment including this Act, or to connect his drains or private sewer with any storm-water overflow sewer. The Act presents a form of procedure between the local authority and the person desirous of availing himself of the above-mentioned facilities. Any question between the parties may be determined by a court of summary jurisdiction.

Subject to conditions, the owner or occupier of any premises, and the owner of any private sewer without the district of a local authority, shall have the like rights with respect to drainage into the public sewers of that authority as he would have if his premises or sewer were situate within their district.

37. Where plans of a building or extension are in accordance with building byelaws deposited with a local authority the authority shall reject the plans unless either the plans show satisfactory provision for drainage or that the authority in the particular case may properly dispense with any such provision.

Subject to conditions, a drain shall not be required to connect with a sewer unless the sewer is within 100 feet of the site of the building. Two or more buildings may be drained in combination if it appears to the local authority that such arrangement would be nore economical or advantageous.

39. If it appears to the local authority that in the case of a building (1) its drainage system is not as defined in the Act, (2) its cesspool, private sewer, soil-pipe, rain-pipe or other such appliance is insufficient or defective, (3) its cesspool or other such appliance is prejudicial to health or a nuisance or (4) any disused cesspool, private sewer or drain is prejudicial to health or a nuisance, they shall by notice require the owner or occupier of the building to do such work as may be necessary for renewal, repair or cleansing. These provisions do not apply to buildings held or used by statutory undertakers.

No rain-pipe from a roof shall be used to convey soil or drainage from a sanitary convenience. No pipe for surface water shall be permitted to act as a ventilating shaft for any drain or sewer conveying foul water. In the event of contravention the local authority may by notice require the owner or occupier of the premises to remedy the matter.

In a borough or urban district, and in certain cases in a rural district, notice except in emergency must be given to the local authority of an intention to repair, reconstruct or alter an underground drain.

43. **Sanitary Conveniences for Buildings.** Where the plans of a building or extension are, in accordance with building byelaws, deposited with a local authority the authority shall reject the plans unless the plans show that sufficient and satisfactory closet accommodation, consisting of one or more water closets or earth closets, will be provided, or the authority are satisfied that in the particular case they may properly dispense with the provision of closet accommodation. Unless a sufficient water supply and sewer are available the local authority shall not reject the plans on the ground that the proposed accommodation includes an earth closet or earth closets and, if the proposed building is likely to be used as a factory in which persons of both sexes will be employed, the authority shall reject the plans unless the plans show sufficient and satisfactory separate closet accommodation for persons of each sex, or the authority are satisfied that in the particular case they may properly dispense with the provision of such separate accommodation. Questions arising may be determined by a court of summary jurisdiction.

Where a building has insufficient closet accommodation or its closets which constitute a nuisance, are so defective as to require reconstructio the local authority shall by notice to the owner of the building requir him to carry out the necessary works. Where such defective closets ca without reconstruction be put into a satisfactory condition the loca authority shall by notice require the owner or occupier of the buildin to take appropriate steps by cleansing or otherwise.

46. In a borough or urban district and certain rural districts o contributory places every building which is used as a factory shall b provided with sufficient and satisfactory sanitary conveniences, regar being had to the number of persons employed and, when both sexes ar concerned, to the sufficient and satisfactory separate accommodation fo persons of each sex, unless the local authority are satisfied that such separate accommodation is unnecessary. If these provisions are not complied with the local authority shall by notice require the owner or occupier to make the necessary alterations.

The replacement of earth closets by water closets may be effected at the joint expense of the owner and the local authority.

48. **Supplemental Provisions.** A local authority has power to inspect and test drains, sanitary conveniences and cesspools believed to be defective. If they deem it necessary they may open the ground, but they may not apply the test of water under pressure.

A room over a closet other than a water closet or earth closet or immediately over a cesspool, midden or ashpit shall not be occupied as a living room, sleeping room or work room. Any person who after seven days' notice from the local authority occupies the room or permits it to be occupied in contravention of the above shall be liable to a fine up to £5. If the person persists after conviction there is a further fine up to 40s. per day.

50. If a cesspool soaks or overflows, the local authority may require the person by whose act, default or sufferance the soakage or overflow occurred to execute such works or effect such periodical cleansings as may be necessary for preventing the soakage or overflow.

The occupier of every building provided with a water closet must keep the flushing apparatus supplied with sufficient water, and when necessary take precautions against frost. An earth closet should be kept supplied with dry earth or suitable deodorising material.

52. Where a sanitary convenience is used by two or more families, if any person injures or improperly fouls the convenience or anythin used with it, or wilfully or by negligence causes an obstruction in the drain, he is liable to a fine up to 10s. If the convenience or the approach thereto falls into an insanitary state for the want of proper cleansin or attention, such of the persons having the common use of the convenience as are in default or, in absence of proof as to which of them is in default, all users of the convenience are liable to a fine up to 10s.

53. **Provisions as to Buildings.** Where plans deposited with a local authority show that it is proposed to construct the building of materials

which are short-lived or otherwise unsuitable for permanent buildings, the authority may, notwithstanding that the plans conform with the byelaws, either reject the plans or, in passing them, fix a period on the expiration of which the building must be removed. A local authority may from time to time extend any period fixed. Any person aggrieved by the action of a local authority may appeal to a court of summary jurisdiction. When the time expires the owner of the building must remove it. If he fails to do so the local authority must remove it and may recover expenses from the owner.

A local authority have power to prohibit the erection of buildings on ground filled up with offensive material. They must reject plans unless it can be shown to them that satisfactory means of access from the house to a street for the removal of refuse can, and will, be provided. No person may close or obstruct such means of access except with the consent of the local authority. Any person who contravenes shall be liable to a fine up to £5. Yards and passages are to be paved and drained. Entrances to certain courts must not be closed or narrowed.

58. If it appears to a local authority that any building or structure is dangerous and dilapidated the authority may apply to a court of summary jurisdiction. If the danger arises from the condition of the building or structure the court may make an order requiring the owner to execute works which will obviate the danger or, if he so elects, to demolish the building or structure or any dangerous part, and remove any resulting rubbish. If the danger arises from overloading of the building or structure the court may make an order restricting the use thereof until a court of summary jurisdiction, any necessary work having been executed, withdraws or modifies the order. If the person on whom an order is made fails to comply, he is liable to a fine, and the local authority may do the work and recover expenses. If the danger from the building or structure is imminent the authority may shore up or fence off the building or structure and recover expenses from the owner.

59. In the case of certain proposed public and other buildings any plans deposited must be rejected by the local authority unless the plans show that the building will be provided with such means of ingress and egress and passages or gangways as the authority deem satisfactory, regard being had to the purposes for which the building is intended to be used and the number of persons likely to be there at any one time. The person in charge must keep the passages and gangways clear while persons are assembled. If he fails to do so the fine is up to £20. This section applies to such buildings as theatres, halls, restaurants, stores, warehouses, clubs, some schools, churches, chapels and other buildings of public resort.

In the case of certain buildings more than two storeys high, in which the floor of any upper storey is more than 20 feet from the ground, a local authority shall by notice require the owner of the building, or any person proposing to erect such a building, to execute such work, or make such other arrangements, as will provide means of escape in case of fire.

61. **Building Byelaws.** Every local authority may, and if required by the Minister must, make building byelaws as to construction, building materials and space about buildings: lighting, ventilation, dimensions of rooms and height of buildings: drainage, cesspools and ashpits: wells, tanks and cisterns for the supply of water for human consumption: stoves and other fittings, not electric, as required for health and fire prevention.

Certain byelaws may be applied to existing buildings. A local authority may relax byelaws with the consent of the Minister. If any work to which building byelaws apply contravenes these byelaws the local authority may by notice require the owner to remove the work or amend it. Questions arising under building byelaws may be referred to the Minister.

72. **Removal of Refuse.** A local authority may, and if required by the Minister shall, undertake the removal of house refuse and the cleansing of earth closets, privies, ashpits and cesspools in either the whole or part of their district. Where a local authority who have so undertaken receive notice from an occupier of premises in their district requiring them to remove any house refuse from these premises, or to cleanse any earth closet, privy, ashpit or cesspool used by the occupants of these premises, and without reasonable excuse fails to comply with the notice within seven days, the occupier of the premises may recover summarily as a civil debt from the authority 5s. for every day during which the default continues.

A local authority who have undertaken as above may make byelaws to facilitate the work. A local authority who have not so undertaken may make byelaws requiring the occupants of premises to remove and cleanse at stated intervals. A local authority may undertake the removal of trade refuse under similar conditions.

75. Where a local authority have undertaken the removal of house refuse they may require owners and occupiers to provide covered dustbins, as many and such in size and construction as the authority approve. If a person does not take care of his dustbin or replace it when worn out the local authority may provide him with a new dustbin at his own expense. A local authority may themselves provide and manage the dustbins, charging in respect of each up to 2s. 6d.

A local authority may provide for the deposit and disposal of refuse and for prohibiting interference with dustbins and refuse tips. They may undertake the sweeping and watering of streets, and the scavenging of common courts and passages. They may make byelaws for (1) the occurrence of nuisance from snow, filth, dust and ashes and (2) the keeping of animals so as to be prejudicial to health.

83. **Filthy or Verminous Premises or Persons.** When it appears to a local authority upon a certificate of the medical officer of health or the sanitary inspector that any premises used for human habitation are in such a filthy or unwholesome condition as to be prejudicial to health or are verminous, the authority shall give notice to the owner or occupier requiring him to remedy the condition by cleansing, disinfecting and

white-washing as may be specified in the notice. In the case of verminous premises the notice may include the removal of wallpaper and such steps as may be necessary for destroying or removing vermin. If the person on whom the notice was served fails to comply, the authority may themselves carry out the requirements and recover the expenses from the person. Either way, the person is liable to a fine and a further fine for every day on which the offence continues.

If gas is to be used by the authority for destroying vermin on the premises the notice must be served on both owner and occupier and the authority must bear the cost of the operations. They may provide temporary shelter for persons compelled to vacate the premises by reason of the operations.

When it appears to the local authority, on the same certification as above, that any article in any premises is so filthy that its cleansing, purification or destruction is necessary to protect the health of any person on the premises, or that it is verminous or likely to be verminous, the local authority shall cause that article to be cleansed, purified, disinfected or destroyed at their expense and, if necessary, removed from the premises.

85. Upon the application of any person a county council or a local authority may take such measures as are in their opinion necessary to free the person and the person's clothing from vermin.

Where it appears to a county council or a local authority upon a report from their medical officer of health, or in the case of a local authority from their sanitary inspector, that any person or the clothing of any person is verminous, then if that person consents to be removed to a cleansing station they may cause him to be removed to such a station. If he does not consent, they may apply to a court of summary jurisdiction, who may make an order for his removal to such a station and for his detention therein. When the person has been thus removed the county council or local authority shall take such measures as they think necessary to free him and his clothing from vermin. The cleansing of females shall be carried out only by a registered medical practitioner or by a woman duly authorised by the medical officer of health. No charge shall be made for the cleansing, removal or maintenance. A county council or local authority may provide cleansing stations.

87. A local authority may provide public sanitary conveniences in proper and convenient situations and may make byelaws regarding them. No person may erect such a convenience in a street without the consent of the local authority. A local authority may require adequate sanitary conveniences to be provided by owners or occupiers of inns, public houses, refreshment houses and places of public entertainment.

90. In this part of the Act the following expressions have the meanings assigned to them:

'cesspool' includes a settlement tank or other tank for the reception or disposal of foul matter from buildings:

'closet' includes privy:

'earthcloset' means a closet having a movable receptacle for the reception of faecal matter and its deodorisation by the use of earth, ashes, chemicals, or by other methods:

'sanitary conveniences' means closets and urinals:

'surface water' includes roof water:

'vermin' in its application to insects and parasites includes their eggs, larvae and pupae, and the expression 'verminous' shall be construed accordingly:

'watercloset' means a closet which has a separate fixed receptacle connected to a drainage system and separate provision for flushing from a supply of clean water either by the operation of mechanism or by automatic action.

PART III

Nuisances and Offensive Trades

91. **Inspection.** It is the duty of a local authority to cause their district to be inspected from time to time for the detection of nuisances.

92. **Statutory Nuisances.** These are

Any premises in such a state as to be prejudicial to health or a nuisance:

Any animal kept in such a place or manner as to be prejudicial to health or a nuisance:

Any accumulation or deposit which is prejudicial to health or a nuisance:

Any dust or effluvia caused by any trade, business, manufacture or process and being prejudicial to the health of, or a nuisance to, the inhabitants of the neighbourhood:

Any noxious or overcrowded factory which is prejudicial to health:

Any other matter declared by any provision of this Act to be a statutory nuisance.

93. Where a local authority are satisfied of the existence of a statutory nuisance they shall serve an 'abatement notice' on the person by whose act, default or sufferance the nuisance arises or continues or, if that person cannot be found, on the owner or occupier of the premises concerned, requiring him to abate the nuisance by appropriate means.

Where the nuisance arises from a structural defect the notice should be served on the owner. Where the person responsible cannot be found, but is clearly neither the owner nor the occupier, the local authority may do forthwith what they consider necessary to abate the nuisance and prevent its recurrence.

If the person on whom an abatement notice was served takes no action, or if the nuisance though abated is likely to recur, the authority shall make a complaint to a justice who shall thereupon issue a summons requiring the person to appear before a court of summary jurisdiction. If at the hearing it is proved that the alleged nuisance exists or, having been abated, is likely to recur, the court shall make a 'nuisance order' either (1) to abate the nuisance within a time specified in the order or (2) to execute any works necessary to prevent a recurrence, also within a specified time, or to do both of these things. The fine for non-compliance is up to £5.

When proceedings are brought in respect of nuisance from accumulations or deposits necessary to a manufacture it shall be a defence for the defendant to prove that the best practical means are taken to prevent the material complained of from being 'prejudicial.' The same defence is good under similar conditions for nuisances from dust or effluvia. The power of a local authority to proceed in respect of nuisance is not impaired by the circumstance that the cause of nuisance arises in an outside district.

101. **Smoke Nuisances.** Any installation for the combustion of fuel for any manufacturing or trade process, or for working engines by steam, which does not so far as practicable prevent the emission of smoke to the atmosphere, and any chimney (not being the chimney of a private house) emitting smoke in such quantity as to be a nuisance shall be statutory nuisances and in this Act are referred to as 'smoke nuisances.'

Where in the opinion of an authorised officer of a local authority a smoke nuisance exists he shall as soon as practicable notify the occupier of the premises on which the nuisance exists, and if that notification was not in writing, confirm it in writing within 24 hours. Procedure with respect to smoke nuisance follows the same general lines as those above described for statutory nuisances.

A local authority may, and if required by the Minister shall, make byelaws regulating the emission of smoke of such colour, density or content as may be prescribed. Building byelaws may require the provision in new buildings, other than private houses, of such arrangements for heating or cooking as are calculated to prevent or reduce the emission of smoke.

A local authority may be empowered to undertake investigations and research into problems relating to atmospheric pollution and the abatement of smoke nuisance.

107. **Offensive Trades.** Any person who, on any premises within a borough or urban district or a rural district or contributory place in which Section 112 of the Public Health Act, 1875, was in force immediately before the commencement of this Act, establishes without the consent of the local authority any offensive trade as hereafter defined shall be liable to a fine of £50.

The expression 'offensive trade' means any of the following trades or businesses, that is to say, the trade or business of a

> blood boiler, blood drier, bone boiler, fat extractor, fat melter, fellmonger, glue maker, gut scraper, rag and bone dealer, size maker, soap boiler, tallow melter, tripe boiler, or

any other trade, business or manufacture

> which under the Public Health Acts Amendment Act, 1907, was immediately before the commencement of this Act an offensive trade, or which the local authority, by order confirmed by the Minister, have after the commencement of this Act declared to be an offensive trade,

provided that any order in force immediately before the date of commencement of this Act declaring the trade or business of fish frying to be an offensive trade shall at the expiration of three years from that date cease to have effect.

Any consent given by a local authority under this section may authorise the carrying on of the trade for a specified period or for such extension of that period as may from time to time be granted by the authority, and any person carrying on the trade after the expiration of the period or any extension thereof shall be liable to a fine up to £5 for each day on which he carries on the trade after notice from the authority that the period or extension has expired.

Any person aggrieved by the refusal of a local authority to consent under this section to the establishment of a trade, or by any time limit attached, or by their refusal to extend such a time, may appeal to a court of summary jurisdiction.

For the purposes of this section a trade, business or manufacture shall be deemed to be established not only when it is established in the first instance but also when it is transferred or extended, or resumed on any premises on which it was previously carried on after being discontinued for more than eighteen months, or when the buildings in which it is carried on are enlarged, but a change of ownership or occupation or the rebuilding of buildings when they have been wholly or partially pulled down or burnt down without any extension of the total floor space shall not be deemed to be an establishment.

Every urban authority may, and if required by the Minister shall, make byelaws with respect to the business of fish frying carried on at any premises or streets within their district in order to prevent any noxious or injurious effects.

109. Nothing in this Part of this Act shall be construed as extending to mines or the heavy metal trades so as to interfere or obstruct any of their processes.

In determining whether the best practicable means have been taken for preventing or counteracting the effect of a nuisance a court shall have regard to cost and to local conditions and circumstances.

PART IV

Water Supply

111. **General Duties.** It is the duty of every local authority to take steps for ascertaining the sufficiency and wholesomeness of the water supplies within their district, and to provide a supply of water to every part of their district so that every house and school has within a reasonable distance a sufficient supply of wholesome water for domestic purposes.

Waterworks. For the purpose of providing their district or a part of it with water a local authority may construct, lease or purchase waterworks, and may purchase the right to take and convey water. They may not impose their supply upon a part of their district which is within the limits of any statutory water undertakers without the consent of such undertakers.

118. A local authority who propose to construct a reservoir other

than a service reservoir of not more than 100,000 gallons capacity shall publish their intention and particulars regarding it in a local newspaper. Unless within 28 days all notices of objection are withdrawn, or the Minister after a local enquiry has approved the proposals, the local authority cannot proceed.

The powers and duties and restrictions of a local authority in respect of the laying and maintenance of water mains are the same as for sewers in Part II of this Act.

124. **Public Wells and Pumps.** All public pumps, wells, cisterns, reservoirs, conduits and other works used for the gratuitous supply of water to any part of the district of a local authority shall vest in and be under the control of the authority, and the authority may cause the works to be maintained and supplied with wholesome water or they may substitute equivalent works equally convenient.

A parish council may utilise any well, spring or stream within the parish and provide facilities for obtaining water therefrom, executing any works required. They may not however interfere with the water rights of any person or restrict any powers of the local authority.

126. **Charges for Water.** A local authority who supply water for domestic purposes may charge a water rate which shall be assessed on the net annual value of the premises in the valuation list. An additional charge may be made for a fixed bath over 50 gallons capacity or for a hose-pipe for horses and vehicles. For certain premises the water used shall be taken by meter. Where the local authority have provided a stand-pipe from which persons may obtain water they may recover water rates from the owner or occupier of every house within 200 feet of the stand-pipe.

132. **Byelaws.** A local authority may make byelaws for preventing the waste, undue consumption, misuse or contamination of water supplied by them. Such byelaws may prescribe in detail the water fittings to be used. Where water fittings used by any person fail to comply with such byelaws the local authority may cause them to be repaired, replaced or altered and the cost added to the water rate. A local authority who supply water may make a charge for any meter provided.

137. **Water Supply of Houses.** Where plans of a house are deposited with a local authority the authority shall reject the plans unless there is put before them a proposal for providing in or near the house a supply of wholesome water sufficient for the domestic purposes of the inmates, and unless they are satisfied that the proposal can, and will, be carried into effect. If after such plans have been approved it appears to the local authority that the proposal for providing the water supply defined above has not been carried into effect, the authority shall give notice to the owner of the house prohibiting him from occupying it or permitting it to be occupied, until the authority, being satisfied that the water supply defined has been provided, have granted him a certificate to that effect. Until then he shall not occupy the house or permit its occupation. Any person aggrieved by the withholding of the certificate may apply to a court of summary jurisdiction.

When a local authority are satisfied that any occupied house has not, in the house or near it, a supply of wholesome water for the domestic needs of the inmates, and that such a supply ought to be provided by the owner, the authority may give notice to the owner requiring him within a time specified to provide, or secure the provision of, such a supply. If two or more houses are concerned a joint supply may be arranged. If the notice to the owner is not complied with the local authority may themselves provide or secure the supply and recover expenses.

If an owner, to whom a notice was given by a local authority as above requiring him within a time specified to provide for his house a supply of wholesome water sufficient for the domestic purposes of the inmates, objects to the requirement of the authority on the ground that

(1) the supply is not required,
(2) the time is too short,
(3) the authority themselves should supply the water,
(4) part of the expenses should be borne by the authority,

he may, within 28 days after the service on him of the notice, appeal to the Minister. If he so appeals, the authority cannot proceed until authorised by the Minister.

140. **Protection of Public.** If a local authority are of the opinion that the water of any well, tank or other source not vested in them, being water which is, or is likely to be, used for domestic purposes or in the preparation of food or drink for human consumption is, or is likely to become, so polluted as to be prejudicial to health, the authority may apply to a court of summary jurisdiction, and thereupon a summons may be issued to the owner or occupier of the premises to which the supply belongs or to any other person alleged to have control thereof.

Upon the hearing of the summons the court may make an order directing the source of supply to be permanently or temporarily cut off, or the water therefrom to be used for certain purposes only, or such other order as the court deems necessary.

The Court may hear any user of the water who claims to be heard and they may cause the water to be analysed at the expense of the local authority.

If the person on whom an order is made fails to comply, the court may authorise the authority to do whatever may be necessary and recover expenses from the person in default.

Any well, tank, cistern or water-butt used for the supply of water for domestic purposes which is so placed, conducted or kept as to render the water therein liable to contamination prejudicial to health shall be a statutory nuisance for the purposes of Part III of this Act.

142. In this part of the Act the following expressions have the meanings hereby assigned to them:

'statutory water undertakers' means water undertakers either of a local authority or a company, board, committee or person empowered by or under this or any other Act to supply water:

'water fittings' includes pipes, meters, cocks, ferrules, valves, soil-pans, waterclosets, baths, cisterns and other similar apparatus used in connection with water.

PART V

Prevention, Notification and Treatment of Disease

See Section XIX of this Book.

PART VI

Hospitals, Nursing Homes

See Section XVI of this Book.

PART VII

Notification of Births, Maternity and Child Welfare and Child Life Protection

See Section III of this Book.

PART VIII

Baths, Wash-Houses, Bathing Places

221. **Provision of Baths.** A local authority may provide public baths and wash-houses, either open or covered or with or without drying grounds, or public swimming baths and bathing places, either open or covered, or any of these conveniences. A local authority may make such charges for the use of any baths, wash-houses, swimming bath and bathing place under their management as they think fit.

A local authority may make byelaws for the regulation of any baths, wash-houses, swimming and bathing places under their management, and for the regulation of persons resorting thereto, including the exclusion of undesirable persons. Any such byelaw, in addition to providing for the imposition of penalties, may empower any officer of the local authority to exclude or remove any person contravening any of the byelaws. A printed copy or abstract of the byelaws relating to any baths, wash-house, swimming bath or bathing place should be exhibited in a conspicuous place therein.

Any baths, wash-house, swimming bath or bathing place under the management of a local authority shall be deemed to be a public and open place for the purpose of any enactment relating to offences against decency.

Baths and swimming places may be used for swimming contests, or by schools or clubs. They may be closed during the winter months and used or let for other purposes, but no stage play or variety entertainment or cinematograph display can be permitted. A parish council may provide baths, wash-houses, swimming baths and bathing places either within or without their parish.

231. **Public Bathing.** A local authority may make byelaws for public bathing, regulating times and places, stations for bathing huts, the decency of costumes worn by bathers, the maintenance of life-saving appliances and other relevant matters. The authority may also provide huts for bathing on any land belonging to them, and may make charges for the use thereof. Still further, they may make byelaws for swimming baths and bathing pools which are not under their management with a

view to ensuring the purity of the water, the cleanliness of the accommodation, the good conduct of all concerned and the prevention of accidents. A local authority may provide life-saving appliances at such places, whether used for bathing or not, as they think fit.

PART IX

Common Lodging-Houses

235. The expression 'common lodging-house' means a house (other than a public assistance institution) provided for the purpose of accommodating by night poor persons, not being members of the same family, who resort thereto and are allowed to occupy one common room for the purpose of eating or sleeping, and includes, where part only of a house is so used, the part so used.

No person shall keep a common lodging-house or receive a lodger therein unless he is registered as the keeper thereof.

237. Every local authority shall keep a register in which shall be entered the name and residence of every registered keeper of a common lodging-house, the situation of the house, the number of persons authorised to be received in the house, and the names and addresses of the persons who are to act as deputies of the keeper.

No applicant shall be registered as a keeper until an officer of the local authority has inspected the premises and reported, and registration may be refused if the applicant is not a fit person to keep a common lodging-house, or if the premises are not suitable and not suitably equipped as regards sanitation, water supply and means of escape in case of fire. The same procedure as above applies to an applicant for renewal of registration or for the post of deputy keeper. Registration may be refused also if the use of the premises as a common lodging-house is likely to occasion local annoyance. The registration of a person as a keeper of a common lodging-house remains in force up to thirteen months, and may be renewed thereafter in similar thirteen-month periods. A person aggrieved by a refusal to grant or renew registration may appeal to a court of summary jurisdiction.

240. Every local authority may, and if so required by the Minister shall, make byelaws (1) for fixing the number of persons who may be received in a common lodging-house and the separation of the sexes therein: (2) for promoting cleanliness, ventilation and lime-washing in such lodging-houses: (3) for taking precautions when any case of infectious disease occurs in such lodging-house: and (4) for the well-ordering of such lodging-houses.

The keeper of a common lodging-house shall if required by the local authority affix, and keep affixed and undefaced and legible, a notice with the words 'Registered Common Lodging-House' in some conspicuous place on the outside of the house.

Either the keeper or a deputy shall manage the lodging-house, and exercise supervision over the persons using it, and either the keeper or a deputy shall be at the lodging-house continuously between the hours of nine in the evening and six o'clock in the morning of the following day. The local authority may require the keeper of a common lodging-house in which beggars or vagrants are received to report daily to them the lodgers of the preceding day and night.

242. It is the duty of the keeper of a common lodging-house to give immediate notice of cases of infectious disease in the lodging-house to the medical officer of health of the district and also to the relieving officer. If the medical officer of health has reasonable grounds for believing that there is in a common lodging-house a person who is suffering, or has recently suffered, from a notifiable disease, he may make complaint thereof to a justice, and thereupon the justice may by warrant authorise him to enter the lodging-house, and examine any person found therein with a view to ascertaining whether he is suffering, or has recently suffered, from such a disease.

If a local authority is satisfied that a person lodging in a common lodging-house is suffering from a notifiable disease, and that serious risk of infection is thereby caused to other persons, and that accommodation for him is available in a suitable hospital or institution, they may, with the consent of the superintending body of the hospital, order him to be removed thereto and maintained there at their cost.

245. If on the application of a local authority a court of summary jurisdiction is satisfied that in the interests of the public health a common lodging-house should be closed on account of the existence, or recent occurrence, therein of a case of notifiable disease, the court may make an order directing the lodging-house to be closed until it is certified by the medical officer of health to be free from infection.

Any person who fails to comply with any of the provisions of this Part of the Act, or being a registered keeper fails to keep a common lodging-house suitably equipped, or being disqualified applies to be registered as the keeper of a common lodging-house, or in an application for registration makes a false statement, shall be liable to a fine up to £5.

When the registered keeper of a common lodging-house is convicted of any offence under this Part of the Act the court may cancel his registration and disqualify him for such period as the court thinks fit.

PART X

Canal Boats

249. The registration authorities for any canal shall be the local authorities and port health authorities whose districts include, or abut on, some part of the canal. It shall be the duty of every registration authority, and of every local authority within whose district any part of a canal is situate, to carry into effect the provisions of this Part of the Act. Every registration authority within 21 days after the end of each calendar year shall make a report to the Minister as to their performance of the said duty.

A canal boat shall not be used as a dwelling unless duly registered by some registration authority for the canal on which the boat is accustomed to ply, nor shall such boat be used as a dwelling for a greater number of persons, of either sex or any age, than is permitted by the certificate of registration.

It shall be the duty of the Minister to make regulations for the registration of canal boats: for the lettering, marking and numbering of canal boats: for fixing the number, age and sex of the persons permitted to dwell in canal boats, regard being had to cubic space, ventilation, separation of the sexes, general healthiness and convenience: for promoting cleanliness and ensuring the habitable condition of canal boats: and for preventing the spread of infectious disease by canal boats.

252. If a canal boat conforms to the conditions of registration, any registration authority for the canal on which the boat is accustomed to ply shall, upon payment of the prescribed fee, register the boat. Upon registering a canal boat the registration authority shall give to the owner of the boat a certificate of registration in duplicate, identifying the owner and the boat. The master of a canal boat shall have the custody of one of the duplicate certificates, but on his ceasing to be master, or on the boat ceasing to be registered, he shall deliver it to the owner of the boat. A certificate of registration shall cease to be in force if any structural alterations which affect the certificate are made on the boat. A person aggrieved by the refusal of a registration authority to register may appeal to a court of summary jurisdiction.

A local authority or port health authority, on being informed that any person on a canal boat within their district is suffering from an infectious disease, shall cause such steps to be taken for preventing the spread of the disease as they consider necessary, and for that purpose may exercise any of the powers in relation to the prevention of infection conferred upon them in Part V of this Act or the Public Health (London) Act, 1891, including the removal of persons to hospital and the detention of the boat.

255. An inspector appointed by the Minister may be empowered to enter, inspect and detain canal boats. An authorised officer of a local authority, for the purpose of ascertaining whether there is any contravention of regulations on the canal boat or whether there is any person on board suffering from an infectious disease, shall have the like rights of entry, inspection and detention as an inspector sent by the Minister.

258. In this Part of the Act the following expressions have the meanings hereby assigned to them:

'canal' includes any river, inland navigation and lake, and any other waters situate wholly or in part within a county or county borough whether these waters are or are not within the ebb and flow of the tide:

'canal boat' means any vessel, however propelled, which is used for the conveyance of goods along a canal, not being a Thames sailing barge, a seagoing ship, or a vessel used for pleasure purposes only.

PART XI

Miscellaneous

259. **Water Courses, Ditches, Ponds.** The following shall be statutory nuisances for the purposes of Part II of this Act:

Any pond, ditch, gutter or watercourse which is so foul or in such a state as to be prejudicial to health or a nuisance.

Any part of a watercourse, not being a part ordinarily navigated by vessels employed in the carriage of goods by water, which is so choked and silted up as to obstruct or impede the proper flow of water and thereby to cause a nuisance or give rise to conditions prejudicial to health.

A person who throws or deposits any cinders, ashes, bricks, stone, rubbish, dust, filth or other matter likely to cause annoyance into or in any river, stream or watercourse, or who suffers such act to be done, shall be liable in a penalty up to forty shillings.

A parish council may deal with any pond, pool, ditch, gutter or place containing any drainage, filth, stagnant water or matter likely to be prejudicial to health, by draining, cleansing, or covering it, or otherwise preventing it from being prejudicial to health.

A local authority may obtain from a court of summary jurisdiction an order for the cleansing of offensive ditches lying in the adjoining district near, or forming, the boundary. A local authority may require the culverting of watercourses and ditches in places where building is intended.

267. **Ships and Boats** lying in inland or coastal waters are subject to the jurisdiction of either a port health authority or a local authority. If the waters are not in any such district the Minister will arrange.

268. **Tents, Vans and Sheds.** The provisions elsewhere in this Act relating to filthy or verminous premises and verminous persons shall apply to tents, vans, sheds and similar structures used for human habitation as they apply to other premises.

For the purposes of Part III of this Act a tent, van, shed or similar structure which is in such a state or so overcrowded as to be prejudicial to the health of the inmates, or the use of which by reason of the absence of proper sanitary accommodation gives rise whether on the site or on other land to conditions prejudicial to health, shall be a statutory nuisance and the expression 'occupier' in relation to such a structure shall include any person for the time being in charge.

A local authority may make byelaws for promoting the cleanliness and habitable condition of tents, vans, sheds and similar structures used for human habitation, for preventing the spread of infectious disease and the occurrence of nuisance.

The power of a court before which proceedings are brought in respect of the above-mentioned statutory nuisance or contravention of byelaws shall include power to prohibit the use for human habitation of the tent, van, shed, or other structure in question at such places or within such area as may be specified.

269. For the purpose of regulating movable dwellings in their district a local authority may license persons to allow land occupied by them to be used as sites, and may license persons to erect and use such dwellings, having regard in the former case to the number and classes of movable dwellings and the spaces between them and water supply and sanitary

conditions, and in the latter case to removal at the end of a stated period and sanitary conditions. With certain exceptions a person shall not allow any land occupied by him to be used for camping purposes on more than 42 consecutive days or more than 60 days in any twelve consecutive months.

Land which is in the occupation of the same person as, and within 100 yards of, a site on which there is during any part of any day a moveable dwelling shall be regarded as being used for camping purposes on that day.

A person shall not keep a moveable dwelling on any one site, or on two or more sites in succession, if any one of those sites is within 100 yards of another of them, on more than 42 consecutive days, or 60 days in any twelve consecutive months, unless either he holds in respect of that dwelling such a licence from the local authority as is referred to above, or the owner of each piece of land on which the dwelling is kept holds in respect of that land a similar licence.

Nothing in this section applies to a moveable dwelling which is kept by its owner on land occupied by him and used for habitation by members of his household, or which is kept by its owner on agricultural land and used at seasonal farming operations, or which belongs to the proprietor of a travelling circus, round-about, amusement fair or the like and is regularly used by him in the course of business, or which, though kept, is not used for habitation.

If an organisation satisfies the Minister as to its camping sites and moveable dwellings the Minister may grant to that organisation certificate of exemption.

A person who contravenes any of these provisions or fails to comply with any condition attached to a licence granted to him shall be liable to a fine up to £5.

270. **Hop-pickers.** A local authority may make byelaws for securing the decent lodging and accommodation of hop-pickers and other persons engaged temporarily in picking, gathering, or lifting fruit, flowers, bulbs, roots or vegetables within their district.

PART XII

General

283. The Minister may by regulation prescribe the form of any notice or advertisement for the purposes of the Act. Such documents should be authenticated by signature of the clerk of the council or other officer authorised by them. The expression 'signature' includes a facsimile of a signature by whatever process reproduced.

287. Any authorised officer of a council shall, on producing if so required some authenticated document showing his authority, have a right to enter any premises for the purposes of the Act at all reasonable hours, provided always that admission to any premises not being a factory shall not be demanded as of right unless twenty-four hours' notice of the intended entry has been given to the occupier.

288. A person who wilfully obstructs any person acting in the execution of this Act or of any byelaw or order under this Act shall be liable to a fine, and a further fine for each day on which the offence is continued after conviction.

296. All offences under the Act may be prosecuted in terms of the Summary Jurisdiction Acts.

331. Nothing in this Act shall authorise a local authority injuriously to affect any reservoir, canal, watercourse, river, stream or feeder, in respect of the quality or fall of water, without the consent of any person who, but for this Act, would still be protected by his water rights.

343. In this Act, unless the context otherwise requires, the following expressions have the meanings hereby assigned to them:

> ‘ coastal waters ’ means waters within a distance of three nautical miles from any point on the coast measured from low-water mark of ordinary spring tides:
>
> ‘ drain ’ means a drain used for the drainage of one building or of any buildings or yards appurtenant to buildings within the same curtilage:
>
> ‘ house ’ means a dwelling-house, whether a private dwelling-house or not:
>
> ‘ inland waters ’ includes rivers, harbours and creeks:
>
> ‘ prejudicial to health ’ means injurious, or likely to cause injury, to health:
>
> ‘ private sewer ’ means a sewer which is not a public sewer:
>
> ‘ public sewer ’ means a sewer which is vested in a local authority:
>
> ‘ sewer ’ does not include a drain as defined in this section but, save as aforesaid, includes all sewers and drains used for the drainage of buildings and yards appurtenant to buildings:
>
> ‘ street ’ includes any highway, including a highway over any bridge, and any road, lane, footway, square, court, alley or passage, whether a thoroughfare or not.

PUBLIC HEALTH OFFICIALS

The principal executive officer of a local authority for public health is the Medical Officer of Health who is, except in London, appointed in terms of the Sanitary Officers (Outside London) Regulations, 1935, and is required to possess a registered Diploma in Public Health, or its equivalent. The regulations prescribe the qualifications, mode of appointment, tenure of office and duties of the medical officer, who may have charge of a county, county or non-county borough, urban district or rural district. The appointment is subject to the approval of the Minister of Health. The duties of the medical officer of health are, broadly, to safeguard the health of his area by all means at his disposal, to advise his local authority on medical matters affecting community well-being and to administer the local health services, including maternal and child welfare, school medical inspection, zymotic disease control, care of the sick poor, and of the blind, and the services for mental health. In addition, he takes to do with such environmental matters as housing and town planning, water supply and food control. He is concerned also in health education and propaganda. In certain areas he is responsible for the supervision of the sanitary department and it inspectorate. He may also take a share in the framing of local byelaw relative to health matters. Each medical officer of health is required t furnish an annual report on the health of his area under the six mai headings of (1) vital statistics and social conditions, (2) health service in general, (3) sanitary conditions, (4) housing, (5) food inspection an (6) infectious disease control. He may have a medical assistant o assistants, who should also possess the Diploma in Public Health or it equivalent. Other medical men or women in local service are th superintendents of general hospitals, infectious diseases hospitals o sanatoria: tuberculosis officers, who are required to have been qualifie for three years and to have had at least six months special experienc of tuberculosis: venereal diseases officers, who must have attended at a recognised treatment centre for a period of not less than three months: maternity and child welfare officers, in whose case special experience i midwifery and child care is demanded: and public assistance medica officers. For these the Diploma in Public Health is not prescribed a essential but will in many cases be regarded as a recommendation. Fo school work dentists are appointed.

Health visitors are trained nurses who possess also Part I of th certificate of the Central Midwives Board and have taken a special cours of public health training leading to the Health Visitors Certificate of th Royal Sanitary Institute. The duties of the health visitor include attendance at ante-natal and child welfare clinics, school clinics and tuberculosi dispensaries, together with follow-up work and home visitation in an or all of these fields. The health visitor may be employed also in routin surveys and in other work connected with the collection of statistica data. In cities, her duties in some ways correspond closely with thos of the almoner.

Sanitary Inspectors are required to possess the Certificates of th Royal Sanitary Institute and Sanitary Inspectors Examination Board The course of training, which extends over eighteen months, includes a six-months part-time course of lectures in theoretical and applie sanitary science, building construction, sanitary law and food inspection together with one year's practical instruction under the guidance of a senior sanitary officer. The duties of the sanitary inspector are concerne with housing, drainage, smoke abatement, the inspection of food an food premises, the investigation of nuisance and other environmenta matters. The Royal Sanitary Institute also grants a specialist mea inspector's certificate for which sanitary inspectors are encouraged t qualify.

Other officials comprise veterinary inspectors under the Ministry o Agriculture and Fisheries, milk officers, supervisors of midwives infestation officers and public health nurses.

SCOTLAND

In Scotland the central authority for health is the Department o Health for Scotland, with offices in Edinburgh, acting under the contr and direction of the Secretary of State for Scotland. The duties of the Department in Scotland are similar to those of the Ministry in England. There are four consultative councils: one on medical and allied services, one on local health administration, one on national insurance and one on the Highlands and Islands.

Other central authorities for health in Scotland are the Registrar General for Scotland, the General Board of Control for Scotland, the Scottish Education Department, the Central Midwives Board for Scotland and the General Nursing Council for Scotland. Their functions are similar to those of the corresponding departments in England. The Department of Agriculture for Scotland deals with agriculture, excluding diseases of animals, which are under the charge of the Minister of Agriculture and Fisheries in London. The Ministry of Labour and National Service, the Ministry of Fuel and Power, the Board of Trade, the General Medical Council and the Dental Board include both Scotland and England in their administrative fields.

Medical Officers of Health in Scotland are appointed under the Public Health (Scotland) Act, 1897. Sanitary Inspectors and Health Visitors are required to possess the respective certificates of the Royal Sanitary Association of Scotland.

The local authority areas in Scotland are counties, counties of cities, large burghs and small burghs. The counties of cities are Edinburgh, Glasgow, Dundee and Aberdeen. Large burghs are those containing a population of 20,000 or upwards together with the Burgh of Arbroath. Small burghs are all the rest. For administrative purposes health services are grouped as minor and major. Minor services are those relating to water supply, sewerage, scavenging, nuisances, offensive trades, housing and common lodging houses. Major services are all the rest.

In counties of cities the city council conducts both minor and major services together with education. In large burghs the town council conducts both minor and major services but not education. In small burghs the town council conducts minor services but neither major services nor education. In counties the county council conducts both minor and major services together with education in the landward area of the county. In addition it conducts education only in the large burghs situated within the county boundary and both education and major services in the small burghs.

LOCAL GOVERNMENT (SCOTLAND) ACT, 1929

This is the Act which has so well ordered the local government system of Scotland for health purposes that the types of local authority concerned, and the health services appropriate to each, can for practical purposes be outlined in two short paragraphs as above. On the Appointed Day the new authorities sprang into being, the district and parish councils ceased to exist, and the burghs below 20,000 of population, except Arbroath, lost control of the major services. The Act also grants relief from rates in the case of certain lands and heritages, discontinues

Exchequer grants for certain purposes and provides other grants in lie thereof. It speaks as follows:

1. All the functions of parish councils are transferred to the count council or the town council of a large burgh, as the case may be, excep that certain functions of parish councils relating to burial, cremation an churchyards within small burghs are transferred to the town councils o small burghs. Certain powers of landward parishes, including the pow of making certain representations, are transferred to District Councils.

2. All the functions of district committees within a county and certai functions of the town councils of small burghs within a county are transferre to the county council. The Secretary of State may by Order transfer t the county council certain other functions of small burghs.

3. The town council of a burgh being a county of a city becomes th education authority for that burgh. The functions of all other educatio authorities in Scotland are transferred to the county council of the area.

10. Four united burghs are formed, namely, Kilrenny with Anstruthe Easter and Anstruther Wester, Elie with Earlsferry, Bonnyrigg wit Lasswade and Blairgowrie with Rattray, and two united counties, namely Kinross with Perth, and Nairn with Moray.

11. Local authorities may be combined by order.

14. County councils and town councils of large burghs were require before 31st March, 1930, to submit to the Secretary of State administrativ schemes for discharging their functions relating to education, poor law public health and lunacy and mental deficiency. An administrative schem might provide that any assistance which might be provided either under th Poor Law Acts or otherwise should be provided exclusively otherwise tha under the Poor Law Acts, but not so as to diminish the duty of the counc to provide relief for the poor. The assistance referred to is the maintenanc and treatment of sick persons, including infectious cases and mental de fectives, and provision for expectant mothers, nursing mothers, childre under five, blind persons and for the feeding, clothing and treatment o school children.

25. With certain exceptions county councils by 1st February, 1930, wer required to submit to the Secretary of State a District Council Schem dividing the landward county into districts for each of which there was t be a district council consisting of the members of county council for th area with other elected members.

27. A county council or the town council of a large burgh may subm for the approval of the Department of Health a scheme for the reorganisati of their hospital facilities or for the extension of such facilities. Th Department before approving a scheme of extension must satisfy themselve that the hospital accommodation at the disposal of the council and th accommodation provided by voluntary hospitals and otherwise is no reasonably adequate, and that the council have taken reasonable steps t secure full co-operation with every voluntary hospital, university or medic school within or serving their area. Where a scheme has been approve it will be lawful for the council, under the conditions of the scheme, t provide, furnish and maintain for sick persons residing within their are hospitals and houses of reception, supplying such hospitals or houses o contracting for their use or entering into agreements with managers o them. Two or more councils may submit a scheme for the provision b one of them of hospital facilities for the sick in the area of the others.

28. A county council or the town council of a large burgh may recove from any person who has been maintained by them in any institutio other than as an inmate of an institution for the purpose of receiving trea ment for infectious disease, or from any person legally liable to mainta that person, a reasonable charge for maintenance and treatment, or if th person from whom such charge is recoverable is unable by reason o

circumstances other than his own default to pay the whole of such charge, such part of it, if any, as he is in the opinion of the council able to pay.

29. A county council or the town council of a large burgh may expend money on health propaganda.

33. A county council may agree to contribute in relief of the financial burden of a special district. Where any enactment empowers a county council to take steps to form a special district upon receiving a requisition, the county council may, on passing a resolution to that effect, proceed as if they had received a requisition for the purpose.

34. Where the Department of Health, after local enquiry, are satisfied that a local authority have failed to discharge their public health functions, the Department may, by Order, authorise another local authority to discharge the functions which the defaulting local authority have failed to discharge.

35. On a vacancy arising in the post of Medical Officer of Health of a small burgh, the county Medical Officer of Health, unless the Department of Health otherwise agree, must be appointed to the post. No person except with the sanction of the Department may be appointed sanitary inspector of a county or burgh unless he possesses such qualifications as may be prescribed by the Department.

44. Provision is made to reduce the rateable value of agricultural, industrial and freight transport lands and heritages, involving corresponding 'losses on account of rates' by local authorities.

52. Provision is made to discontinue certain grants including those payable on the basis of a percentage of the expenditure by local authorities on maternity and child welfare other than the training of midwives and health visitors, tuberculosis, venereal diseases, welfare of the blind and mental defectives, involving corresponding 'losses on account of grants' by local authorities.

53. Provision is made as to an annual contribution towards local government expenses in counties and large burghs to be called the 'General Exchequer Contribution.' It is to be made up of an amount equal to the total 'losses on account of rates' above, and an amount equal to the total 'losses on account of grants' above, together with a sum at first of £750,000 and later as determined periodically by Parliament.

55. The General Exchequer Contribution is to be apportioned to county councils and the town councils of large burghs for the first seventeen years on the basis of a falling percentage of the losses of each on account of rates and grants and an apportionment of the residue according to weighted population. After the seventeenth year the whole of the General Exchequer Contribution is to be apportioned according to weighted population.

56. Provision is made as to additional and supplementary grants to counties and large burghs, as to grants to small burghs, and as to contributions by councils to voluntary associations in respect of the welfare of the blind and the supervision of mental defectives not in institutions.

66. The Secretary of State may reduce the General Exchequer grant to any council in any year either (1) if the council have failed to maintain a reasonable standard of efficiency and progress in their public health services, regard being had to the standards maintained in similar areas, or (2) if their expenditure has been excessive and unreasonable, regard being had to their financial and other circumstances.

73. *County* includes any small burgh situated within the county.

77. *Large Burgh* means a burgh containing a population of 20,000 or upwards and includes the burgh of Arbroath.

Small Burgh means any burgh other than a large burgh.

The Act came into operation on 16th May, 1930.

The weighted population is the estimated population for the year, increased according to rules laid down by percentages in respect of the following factors: (*a*) *Children under five:* the percentage by which the number of children under five years of age per 1000 of population exceeds 50. (*b*) *Rateable value:* the percentage by which the rateable value per head of estimated population is less than £12, 10s. (*c*) *Unemployment:* a percentag reflecting the extent of unemployment of insured persons in the area, an (*d*) *Scarcity of population:* a percentage reflecting scarcity of populatio based upon the numbers of the estimated population per mile of roa Factors *a*, *b* and *c* apply to both counties and large burghs, *d* to countie only.

Section 14 of the Act in so far as relating to 'public health an lunacy and mental deficiency,' and sections 27 and 28, are subject t repeal under the National Health Service (Scotland) Act, 1947.

VIII.

STATISTICS

STATISTICS are figures arrayed in such a manner as to bring out any significance which they may possess. The methods used were first devised with reference to communities such as states, whence the word 'statistics,' and so have come to imply the handling of large numbers. Small numbers do not possess statistical value. By vital statistics we mean statistics applied to the community life of man. As births, marriages and deaths are salient events in human life they hold a recognised position in the statistical field.

The pioneer of vital statistics in this country was John Graunt, a haberdasher and train-band officer in London, who published in 1662 a book containing his ' Observations upon the London Bills of Mortality.' These bills were records of the numbers of christenings, representing births, and burials, representing deaths, which took place in London parishes. Graunt commented in his book upon the excess of male over female births and also upon the excess of the death rate in the city over that in the country. He drew attention also to the high death rate among young children. His work was of value, though he laboured under a difficulty not of his own creation. The last census of London had been taken in 1631, and even the poll-tax list was twenty years old. While therefore his figures for births and deaths were contemporary and, within limits, reliable, he had not recent information as to the number of the people among whom these births and deaths occurred.

Accurate knowledge of populations is essential to vital statistics. Other things being equal, according as a population is large or small the births or deaths occurring in it will be frequent or few. The statistical significance of the number of births or deaths is in great measure conditioned by the size of the population, a figure for which must therefore be introduced into our statistical estimates. If we divide the population into the number of births or deaths and multiply the quotient by 1000 we get the birth or death rate per 1000 of the population. By working out such rates for various populations we are enabled to compare populations of different sizes with one another, whether they are populations of different areas or of the same community at different stages of its development.

The application of mathematical principles to the compilation of vital statistics began in the early part of the 19th century and soon thereafter the collection of demographic data became official procedure. To William Farr, appointed an assistant commissioner for the census in 1851, is due the credit for our national system of registration.

CENSUS

The census or count of the population of the whole country has, unt lately, been taken in the United Kingdom every 10 years. The first wa in 1801 and the fourteenth, the last for the time being, in 1931. Th date has usually been round 1st April. No 5-yearly census has yet bee taken, although permitted by the Census Act of 1920.

Under the Census Act, the date of each census is prescribed by Orde of the King in Council. The Registrars General for England an Scotland prepare the census statistics and issue the census reports fo their respective countries. It is their duty also to supply statistica information for non-census years.

In taking the census, each registration district is divided int enumeration districts under enumerators, whose duty it is to issue t householders, and recover, the census schedules. Particulars are require regarding each person who resided in the house on the night whic ushered in the census day. A 'house' is a dwelling with an outside doo or a door opening into a common stair or passage. Persons arriving a the house on census morning, if not previously recorded, are to b included in the household return. Boarders are to be entered in th household return but lodgers have a separate schedule. Special arrange ments are made for the enumeration of persons on board ship and i institutions. Enumerators are expected to submit particulars as t vagrants in their area, with police co-operation where necessary. Eac enumerator sends his collected schedules, after scrutiny and correctio to the local registrar, accompanied by an enumeration book into whic he has transcribed the particulars. From these papers the local registra prepares his registrar's summary, which he transmits with the papers t the Registrar General by an appointed date.

In compiling their census statistics the Registrars General emplo automatic sorting and tabulating machines. The data are first numerical coded, and then transferred to cards by punching out holes with a ke punch. The perforated cards are then sorted in an electrical sortin machine, which consigns each card to its appropriate group by mea of a mechanism activated by contacts made through the punched-o holes. The groups of cards are finally counted in a tabulating machin on the indicator of which the resulting figures are automatically display

In 1931 the principal schedule headings for England were as follow name: relation to head of household: usual residence: sex: ag whether married, single, widowed or divorced: occupation: employe business: birthplace: nationality: and number of rooms. For Wa and Monmouth there was the additional heading: 'whether We spoken,' and for Scotland two additional headings: 'whether Ga spoken' and 'whether entitled to medical benefit under national hea insurance.'

The population of England and Wales at the 1931 census w 39,952,377: of Scotland, 4,842,980. In 1831 the population of Engl and Wales was 6,771,196: of Scotland, 1,114,456. The census du be taken in Britain in 1941 has been postponed by the Second W

War. Owing in part to this cause and in part to the war-occasioned dispersal of population, the existing vital statistics for the country are at present less accurate than is normally the case.

Despite precautions taken, errors occur in the census. Adults ignorant of their precise age concentrate on multiples of 10. Women may understate their ages. Parents may overstate the ages of their children in order to get them put to work. Very old persons, for the reputation it brings them, may add to the tale of their years. Incomplete definition of occupations is a standing difficulty. The census schedule contains examples of occupations with a view to precision under this head.

ESTIMATES OF POPULATION

Since birth, death and other rates require to be calculated for years when there is no census just as in census years, estimates of the population have to be made for years following the last census for the time being. These figures may be obtained by working out (1) the Actual Increase, (2) the Housing Factor, (3) the Electoral Increase or (4) the Arithmetical Increase. There is also (5) the Logarithmic Method.

Actual Increase. This method is used by the Registrars General for estimating the national mean or mid-year populations which are required for statistical purposes. It consists in adding to the previous year's mid-year estimate the actual increase of population in the interval. The actual increase is the natural increase, or number of births minus deaths, together with the migration increase, or immigration minus emigration. These relations are represented by the formula

$$P_n = P_{n-1} + N + M$$

where P_n and P_{n-1} are the mid-year estimates of two consecutive years concerned while N is the natural and M the migration increase between the two mid-years. N is derived by the Registrars General from the registrations of births and deaths and M from figures set forth in the *Board of Trade Journal* and other sources. The quantity M has been negative for Scotland on more than one occasion.

Given the estimated population of Scotland as at mid-year 1925 and the natural and migration increases between mid-year 1925 and mid-year 1926, to estimate the population of Scotland as at mid-year 1926:

Population, Scotland, mid-year 1925		4,893,032
Natural increase, 1925-26	+	37,987
Migration increase, 1925-26	—	34,381
Population, Scotland, mid-year 1926		4,896,638

The actual increase method has the advantage of being based on current events, and has given good results. The estimated population for Scotland for 1921, worked out by the Scottish Registrar General by applying this method from year to year since the 1911 census, only differed from the actual population, as ascertained by the 1921 census, by 1366 or 0·3 per 1000. For England and Wales the corresponding error was only 33,000 or less than one per 1000.

Housing Factor. The actual increase method cannot be used in that form for towns or counties since no direct migration returns are available for local areas. In the housing factor method the number of persons per house in the area concerned is ascertained for census year, say 1931, by dividing the census population, say, 35,812, by the number of houses, say 7,021, on the valuation roll in census year. Then $35812 \div 7021 = 5{\cdot}1$, which is the 'housing factor,' or number of persons per house. The population in any year up to the next census is got by multiplying the number of houses on the roll for that year by the housing factor. Thus if for 1932 the number of houses is 7,009 then $7009 \times 5{\cdot}1 = 35745$, which is the estimated population for 1932.

Electoral Increase. For local estimates in England and Wales the Registrar General distributes the national post-census population among the constituent Boroughs, Urban Districts and Rural Districts of the country by a procedure which may be generally expressed in terms of a formula as follows:

$$I = A + x\,(B - C) - y$$

where I is the rate of increase in the locality requiring to be found.

A, B and C are local characteristics. A is the rate of natural increase, or ratio of post-census natural increase to census population. B is the rate of electoral increase, or ratio of post-census increase in electors to numbers on the autumn register of 1921, either Parliamentary or Local Government figures being used. C is such portion of B as can be regarded as not having been due to migration, for example, increases to the register on account of attainment of franchise age or decreases occasioned by death. C is based upon the local age and sex constitution as given by the census.

x and y are constants applicable to all areas alike. x is a constant, rather less than unity, determined by experience, and used to reduce the weight of the migration index $(B - C)$, since by its nature the authority of the latter is lower than the practically exact record of natural increase A. y is the constant necessary to secure that local estimates aggregate to the total national population to be distributed.

The local census figure multiplied by $1 + I$ gives the estimated local population required.

Arithmetical Increase. According to this method for local estimates the increment for years following the last census is based upon the assumption that the increase of population during the ten-year period between the last census and the last but one has occurred at a uniform rate. In the case of a selected area the estimated population for 193 would be determined thus:

Population Census 1921	4220
Population Census 1931	4640
Increase in 10 years	420
Increase in 1 year	42
Estimated population 1932	4682

That is to say, 42, the annual increment for the previous ten yea period, is added to the census population for 1931.

Logarithmic Method. When the estimated population of a census year, worked out by the post-census method, differs materially from the actual population ascertained by the census count it becomes necessary to recalculate the annual post-census estimates since the preceding census. The method employed in both Scotland and England and Wales is the inter-census or logarithmic method, the population of each inter-census year being calculated from the known inter-census increase, on the assumption that the rate of increase continued evenly in geometrical progression throughout the inter-census period.

Thus, if a population P_o increases for n years at an annual unit rate of increase r, the value of P^n, the population after n years, is given by

$$P_o(1+r)^n=P_n \tag{1}$$

and

$$1+r=\sqrt[n]{\frac{P_n}{P_o}}$$

Further, if R be the decennial rate of unit increase

$$\frac{P_n-P_o}{P_o}=R$$

and

$$\frac{P_n}{P_o}=1+R \tag{2}$$

Therefore

$$1+r=\sqrt[n]{1+R} \tag{3}$$

Given

Census population Scotland 1901 $=$ 4,472,103
Census population Scotland 1911 $=$ 4,760,904.

To recalculate population Scotland as at mid-year 1902:

Taking equation (2):

$$\frac{P_{11}}{P_{01}}=1+R$$

$$\log P_{11}=\log 4{,}760{,}904=6{\cdot}67768946$$

$$\log P_{01}=\log 4{,}472{,}103=6{\cdot}65051179$$

$$\therefore \log(1+R)=\log P_{11}-\log P_{01}=0{\cdot}02717767.$$

Taking equation (3):

$$1+r=\sqrt[10]{1+R}$$

$$\log(1+r)=\tfrac{1}{10}\log(1+R)=0{\cdot}0027177.$$

Taking equation (1):

Since P_{01} is the census population at the end of the first quarter of 1901, $P_{01\frac{1}{4}}$ will represent the population at mid-year 1901, so that:

$$P_{01}(1+r)^{\frac{1}{4}}=P_{01\frac{1}{4}}$$

$$\log P_{01}=6{\cdot}65051179$$

$$\tfrac{1}{4}\log(1+r)=0{\cdot}0006794$$

$$\therefore \log P_{01\frac{1}{4}}=6{\cdot}6511912.$$

Taking equation (1) again:

$$\begin{aligned} P_{01\frac{1}{4}}(1+r) &= P_{02\frac{1}{4}} \\ \log P_{01\frac{1}{4}} &= 6{\cdot}6511912 \\ \log(1+r) &= 0{\cdot}0027177 \\ \hline \therefore \log P_{02\frac{1}{4}} &= 6{\cdot}6539089 \\ \therefore P_{02\frac{1}{4}} &= 4{,}507{,}202 \\ &= \text{Recalculated Population of} \\ & \text{Scotland as at mid-year 1902.} \end{aligned}$$

BIRTHS

Registration. Births in England and Wales are required to be registered within 42 days in the sub-district in which the birth occurred, but any person who has removed from the district without registering may make a declaration of the particulars to another registrar whose duty it will be to transmit it to the registrar concerned. If not effected within 12 months, registration cannot be made without the authority of the Registrar General. Still births in England and Wales are required to be registered in the register of still births.

Births in Scotland are required to be registered within 21 days in the district in which the birth occurred. If not effected within 3 months registration cannot be made without a sheriff's warrant. Still births are now registrable in Scotland also.

Birth Rate. The annual birth rate is the number of registered births in a year per thousand of the mean population. Thus in an area for any year

$$\text{Birth Rate} = \frac{\text{Number of births in year}}{\text{Mean population}} \times 1000.$$

The crude birth rate represents the sum of all the influences which determine the rate at which a population is reproducing itself.

The birth rate in 1945 of England and Wales was 16·1 per thousand; of Scotland 16·9 per thousand.[1]

Masculinity is the proportion of male births per thousand female births. In England and Wales over a period of 50 years it range between 1032 and 1060. More males were born than females.

Fertility Rate. This rate, known also as the corrected birth rate, i the number of registered births in a year per 1000 women of chil bearing ages. Thus

$$\text{Fertility rate, total} = \frac{\text{Number of births in year} \times 1000}{\text{Number of women aged 15-45}}$$

$$\text{Fertility rate, legitimate} = \frac{\text{Number of legitimate births in year} \times 1000}{\text{Number of married women aged 15-45}}$$

$$\text{Fertility rate, illegitimate} = \frac{\text{Number of illegitimate births in year} \times 1000}{\text{Number of spinsters and widows aged 15-45}}$$

Comparative Fertility. As the women of child-bearing ages in community form less than one eighth of the total population, the variation of their numbers and ages taken over a period of years shows differences from the community as a whole. For England and Wales the Registrar General, employing information as to births obtained at the census of 1921, determined for legitimate, illegitimate and total births in that year the number of births per 1000 women at the child-bearing age periods 15-, 20-, 25-, 30-, 35- and 40-45. Applying these rates by the Indirect Method, as explained below[1] for death rates, to the corresponding age periods of child-bearing women in any year desired to be investigated, he obtained an expected number of births which was then compared with the actual births of the year. Thus for 1911, taking legitimate births only, the actual births in England and Wales were 846,347, and the expected births 768,263, giving a ratio of actual to expected of $\frac{846{,}347}{768{,}263} = 1{\cdot}102$, equivalent to a figure for comparative fertility of 1102 per 1000 expected births. The comparative fertility figure for legitimate births is steadily falling in England and Wales.

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[1] Table 3, page 156.

Trend. As shown by Table 3 the birth rate of both England and Scotland has been declining from 28·7 and 29·6 in 1900 to the figures presented for 1945. This downward trend, however occasioned, is regrettable in the national interest.

Useful, though approximate, guides to birth trends are provided by the Reproduction Rates of R. R. Kuczynski. The *Gross Reproduction Rate* for a given calendar year is the average number of female children born to women between the ages of 15 and 45 on the basis of the fertility rates derived from a specially compiled specific female fertility table prevailing at each year of reproductive life in the given calendar year. If a community is to replace itself, each potential mother must produce at least one daughter. The G.R.R. is then 1. When the rate falls below unity, the population must decline, even when every allowance is made for reductions in mortality. If, in spite of increased nuptiality, the G.R.R. remains less than 1, the population is imperilled. By applying to the G.R.R.s the female mortality rates for the various age groups, allowance can be made for chances of survival of potential mothers, and so the *Net Reproduction Rate* can be calculated. A figure above unity suggests a growing population. The N.R.R. for North West Europe, including Great Britain, and that for the United States are now less than 1, while the rates for Japan and the Ukraine are 1·54 and 1·67 respectively.

The diminishing number of births has been ascribed to the increasing practice of birth control. Such methods have received official sanction at welfare centres if advised to married women for health reasons. Their routine use by married persons for other than health reasons is in a different category. In the grim beginnings of the industrial age, before the veto on child labour, poor people's children, even while very young, were a gainful possession to their parents, because they could work in the mills. More recently, children were still accounted a lucrative investment since from adolescence onwards they could aid the family with their earnings and, when they came to middle life, support their parents' declining years. Nowadays families are less cohesive and there are pensions for the old, so that children, no longer such a source of profit, have come to figure as a liability. Young couples starting married life may see in the prospect of children only a hindrance to their freedom of movement or a check upon their pursuit of gaiety, or perhaps an obstacle to their acceptance as tenants of a house or lodging. Furthermore the self-supporting young women now thronging the ranks of industry may for a time look askance at marriage followed by motherhood. In some instances the maternal instinct is satisfied by one or at most two children.

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[1] Page 161.

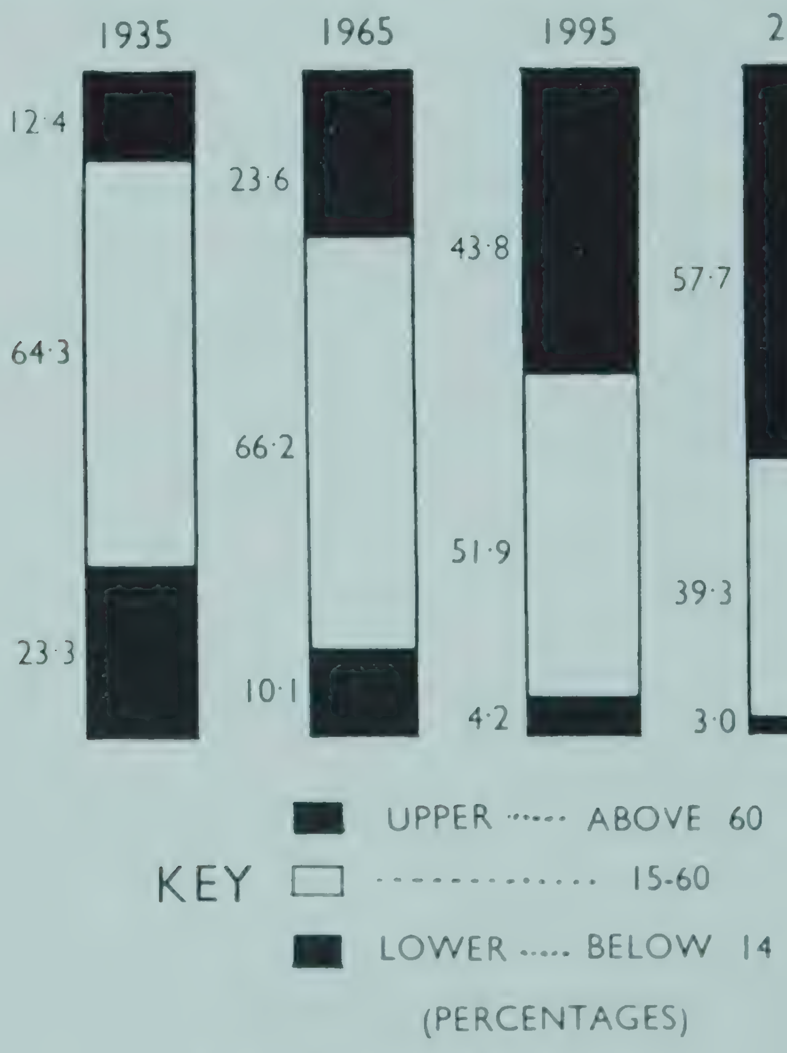

Fig. 30.—Population Trend.

These and similar tendencies, typical of the period, have combined to bring about a widespread disinclination to reproduce. Calculations which have been made suggest that unless this disinclination can be overcome to such an extent that the average number of children in families will be at least 4, our population will continue to decline towards a point when there will not be people enough to hold our position among the nations.

The decline in births and the increased survival rate of the present day have together led to a significant transition in the age group constitution of the population. It has been calculated, present trends continuing, that the age groups 15 to 59, now forming some 65 per cent. of the population, will in 100 years account for only 40 per cent.; that the proportion of children aged 1 to 14 will have shrunk from 24 per cent. to rather less than 3 per cent.: and that the number of persons aged 60 years and over will have doubled (Fig. 30).

Remedies. Among the measures which have been tried with a view to the promotion of fertility are family allowances graded according to the number of children, or remissions of income-taxation similarly adjusted, but either too cautious in their payments or too narrow in their application to make any wide appeal to those who feel reluctant to assume the responsibilities of parenthood under existing social conditions. Now however a new order promises.

Sir William Beveridge in his Report of 1942 presented a scheme for children's allowances which, he says, should be regarded both as a help to parents and as an acceptance of new responsibilities by the community.

It is intended that the scheme should be non-contributory, the allowances being provided wholly out of taxation. The average rate of allowance will be 8s. per child per week, a figure which takes into account both the rise of prices after the War and the provision already made for children by school meals and cheap or free milk. There will be no allowance for a family of one child only when the responsible parent is earning but, as the size of the family increases, the average allowance for each child will increase in accordance with the following scale:

No. of children in family.	Weekly allowances per family.	Average weekly allowance per child.
1	0	0
2	8s.	4s.
3	16s.	5s. 4d.
4	24s.	6s.
5	32s.	6s. 5d.
6	40s.	6s. 8d.

With an allowance of 8s. per child per week the omission of one child when the parent is earning will reduce the total cost of allowances by a most substantial sum. The allowances will continue so long as the child is in approved full time education up to the age of 16. Since little money would be saved by any reasonable income limit it is suggested that the scheme should be open to all.

These proposals receive the force of law in the subjoined statute, except that the basic 8s. of the table is reduced to 5s. and the dependent figures shrink in proportion.

Family Allowances Act, 1945. The Minister of National Insurance will pay, out of moneys provided by Parliament, for every family which includes two or more children, an allowance in respect of each child in the family, other than the elder or eldest, at the rate of 5 shillings per week.

A 'child' means a boy or girl under the upper limit of the compulsory school age, or up to but excluding the first day of August after he or she attains the age of sixteen while undergoing full-time instruction in school, or being an apprentice.

For the purposes of the Act 'family' means one or another of the 3 family groups lettered hereunder:

(a) A man and his wife living together, *plus* any child or children being issue of theirs, his or hers, and any child or children being maintained by them, or

(b) A man not having a wife or not living together with his wife, *plus* any child or children being issue of his, and any child or children being maintained by him, or

(c) A woman not having a husband or not living together with her husband, *plus* any child or children being issue of hers, and any child or children being maintained by her.

In group (a) the allowances belong to the wife but are receivable by either the man or the wife. In group (b) the allowances belong to the man, and in group (c) to the woman.

'Issue' is to be taken as issue of the first generation only. The Schedule to the Act is concerned with the maintenance and allocation of children.

All claims for allowances are due to be addressed to the Minister of National Insurance and any question of right will be decided by him. If any person is dissatisfied by an award or decision of the Minister, the question can be referred to one or more of a panel of referees, whose decision will be final. The appointment and procedure of these referees will be as prescribed by regulation, and fees as approved may be paid to them.

Family allowances will be paid by sums on account thereof, receivable through the Post Office or otherwise as may be prescribed. The Minister may require the repayment of overpayments.

In general a child when removed from the control of its parents may not for the purposes of the Act be included in any family. Among such disqualifying conditions are: being under detention in an approved school, or otherwise under custody, or committed to the care of a local authority. Also a child in respect of whom an orphan's pension is being paid under the Widows', Orphans' and Old Age Contributory Pensions Act, 1936, may not be included. Further adjustments will fall to be made for children in respect of whom equivalent benefits are being paid as out-door relief or under Acts concerned with Workmen's Compensation or Unemployment Insurance, or provisions relating to the Services and War Injury.

Proceedings for an offence under the Act may not be instituted in England except by or with the consent of the Minister or by an officer authorised by him.

A child being legitimate issue of a deceased spouse of any person by an earlier marriage will be treated as issue of that person. If the child is illegitimate, treatment will be the same only so far as regards any period during which the child is living with the person. Where a child born before the marriage of the child's parents has been legitimated by the subsequent marriage of the parents the child will be deemed to be issue of the marriage. A lawfully adopted child will be treated as if the child were legitimate issue of the adopter or adopters.

The expression 'providing for' a child means making available for the child food, clothing, lodging, education, and all other things reasonably required for the child's benefit, having regard to all the circumstances.

It will be a condition of the right to any allowance for a group (a) family that the man is a British subject and born in the United Kingdom or, if not, that he or his wife, either or both of them, comply with such requirements as to nationality and other items as may be provided by Regulations. For a group (b) family these requirements apply to the man and for a group (c) family to the woman. A further condition of the right to any allowance for a group (a) family is that either one or both of the man and his wife are in Great Britain. The same holds with group (b) families for the man and with group (c) families for the woman. It will be a condition of a child's being treated as a member of any family under the Act that the child is in Great Britain.

The Act applies *mutatis mutandis* to Scotland and Northern Ireland.

The following summary throws into relief the salient features of the Act:

Under the Family Allowances Act, 1945, Family Allowances are paid from Government Funds to parents and other persons who maintain children in families. No allowance is paid for the eldest or only child in a family, but a payment of 5s. per child per week is made for other children, beginning at birth. For the purpose of the Act the term ‘child’ is taken to mean a child who is under the upper age limit for school attendance, but a child over that limit who is still at school, or is an ‘apprentice,’ is also regarded as coming within the definition up to the 31st July following his 16th birthday. An apprentice is defined as ‘a person undergoing full-time training for any trade, business, profession, office, employment or vocation, and not in receipt of earnings which provide him, wholly or substantially, with a livelihood.’

Family allowances are not an insurance benefit, payable to insured persons from an insurance fund: nor are they relief or assistance, granted on the basis of need. They are available to all, virtually without conditions. No regard is had to the financial condition of the household, or to any allowances which may be accruing from other sources, or to whether the head of the household is employed, unemployed, or sick. The allowances are paid by the Ministry of National Insurance, by means of books of weekly orders, cashable at Post Offices. They are intended to belong to the mother, and to be used by her for the benefit of the family as a whole.

MARRIAGES

Registration. In England and Wales, in terms of the Registration of Births, Deaths and Marriages Acts, 1836, marriages are required to be registered at the time of marriage, whether that be in a church or in a registered building or in a registrar’s office.

In Scotland in terms of the Marriage (Scotland) Act, 1939, marriages are effected either (1) by a minister of religion as heretofore or (2) in the office of an authorised registrar. First, a notice of the purpose of marriage is sent to the registrar concerned. Seven clear days later, in the absence of objection, the registrar issues his certificate and the marriage can then take place. In certain cases the sheriff may issue a marriage licence.

TABLE 3.

BIRTH RATE. DEATH RATE. INFANT MORTALITY RATE

England and Wales. Scotland. 1900-1945.

	ENGLAND AND WALES.			SCOTLAND.		
	Birth Rate.	Death Rate.	Inf. Mort. Rate.	Birth Rate.	Death Rate.	Inf. Mort. Rate.
1900	28·7	18·2	154	29·6	18·5	129
1901	28·5	16·9	151	29·5	17·9	129
1902	28·5	16·3	133	29·3	17·3	113
1903	28·5	15·5	132	29·4	16·8	118
1904	28·0	16·3	145	29·1	17·1	123
1905	27·3	15·3	128	28·6	16·2	116
1906	27·2	15·5	132	28·6	16·4	115
1907	26·5	15·1	118	27·7	16·6	110
1908	26·7	14·8	120	28·1	16·6	121
1909	25·8	14·6	109	27·3	15·8	108
1910	25·1	13·5	105	26·2	15·3	108
1911	24·3	14·6	130	25·6	15·1	113
1912	23·9	13·3	95	25·9	15·3	106
1913	24·1	13·8	108	25·5	15·5	110
1914	23·8	14·0	105	26·1	15·5	111
1915	21·9	15·7	110	23·9	17·1	126
1916	20·9	14·4	91	22·9	14·7	97
1917	17·8	14·4	96	20·3	14·4	107
1918	17·7	17·6	97	20·5	16·3	100
1919	18·5	14·0	89	22·0	15·6	102
1920	25·5	12·4	80	28·1	14·0	92
1921	22·4	12·1	83	25·2	13·6	90
1922	20·4	12·8	77	23·5	14·9	101
1923	19·7	11·6	69	22·8	12·9	79
1924	18·8	12·2	75	21·9	14·4	98
1925	18·3	12·2	75	21·3	13·4	91
1926	17·8	11·6	70	20·9	13·0	83
1927	16·6	12·3	70	19·8	13·5	89
1928	16·7	11·7	65	19·8	13·3	86
1929	16·3	13·4	74	19·2	14·7	87
1930	16·3	11·4	60	19·6	13·3	83
1931	15·8	12·3	66	19·0	13·3	82
1932	15·3	12·0	65	18·6	13·5	86
1933	14·4	12·3	64	17·6	13·2	81
1934	14·8	11·8	59	18·0	12·9	78
1935	14·7	11·7	57	17·7	13·2	77
1936	14·8	12·1	59	17·9	13·4	82
1937	14·9	12·4	58	17·6	13·8	80
1938	15·1	11·6	53	17·7	12·6	69
1939	14·9	12·1	50	17·4	12·9	68
1940	14·6	14·0	56	17·1	14·8	78
1941	14·2	12·9	59	17·5	14·7	82
1942	15·8	11·6	49	18·1	13·0	69
1943	16·5	12·1	49	18·9	13·3	65
1944	18·0	11·9	45	18·5	12·9	65
1945	16·1	11·4	46	16·9	13·2	56

Marriage Rate. The marriage rate may be expressed as the number of marriages, or alternatively persons married, per thousand of the population. It may be expressed also per thousand of marriageable persons, who are the bachelors, spinsters, widowers, widows and divorced of 15 years or over. In a recent year the marriage rate in terms of marriages per thousand of population was in England and Wales 8·6, in Scotland 7·7.

The mean age at marriage, which showed a tendency to increase during the early decades of the present century, has remained relatively stable of late. In 1930 the mean age of bachelor bridegrooms was 27·33, of spinster brides 25·5.

The marriage rate has been described as a barometer of national prosperity, rising when peace ensues upon war, abundance follows after dearth and wages succeed unemployment. The future of a population depends not only upon the proportion of its members who marry, but also upon their ages at marriage. Late marriage tends to lower replacement potential. Among the medical causes of postponement of marriage are tuberculosis, venereal disease, psychoneuroses and phobias regarding the transmission of familial defects. Social causes include economic necessity and prolonged professional training.

DEATHS

Registration. Deaths in England and Wales are required to be registered within 5 days. The medical practitioner is required to deliver a certificate of the cause of death forthwith to the registrar and at the same time to give to the person effecting registration a notice in writing of the signing of the certificate, which notice must be handed by the informant to the registrar.

In Scotland deaths are required to be registered within 8 days. The medical person in attendance during the last illness and until the death of any person is required to transmit a medical certificate of the cause of death to the registrar within 7 days. It is customary but not compulsory in Scotland for the medical attendant to effect transmission by handing the medical certificate to the informant, who is responsible for effecting the registration of the death.

Death Rates may either be (1) death rates showing the frequency of deaths in an area, or (2) death rates showing the frequency of deaths among the true population of an area, or (3) death rates showing the frequency of deaths when allowance is made for the age and sex distribution of the true population. The terminology, and in some cases the methods, employed by the Registrars General of the two countries of the United Kingdom differ.

Crude Death Rate.[1] The death rate showing the frequency of registered deaths in an area is the crude death rate. It is expressed per thousand of the mean population and may be stated for a year, a week, a month or a quarter: thus

$$\text{Annual Death Rate} = \frac{\text{Number of deaths in year} \times 1000}{\text{Mean population}}$$

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[1] In Scotland called the Uncorrected Death Rate.

$$\text{Weekly Death Rate} = \frac{\text{Number of deaths in week} \times 1000 \times 52.17747}{\text{Mean population}}$$

$$\text{Monthly Death Rate} = \frac{\text{Number of deaths in month} \times 1000 \times 365.24226}{\text{Mean population} \times \text{number of days in month}}$$

$$\text{Quarterly Death Rate} = \frac{\text{Number of deaths in quarter} \times 1000 \times 365.24226}{\text{Mean population} \times \text{number of days in quarter}}$$

The weekly death rate is the annual death rate which would result if the same number of persons as died in the week were to die weekly throughout a year. It obviously gives no information as to the probable annual death rate for the year, but it is of use for comparing consecutive weeks with one another or corresponding weeks in different years in one locality. In addition it serves as a measure of death's activity at the time.

Recorded Death Rate.[1] This rate shows the frequency of deaths among the true population of an area. It is the registered death rate corrected for deaths of non-residents and is usually stated annually. The deaths of non-residents dying in the area are transferred out to where they belong and the deaths of residents dying outwith the area are transferred in from the place of death. Thus the recorded death rate is the number of registered deaths in the year *plus* the transfers-in *minus* the transfers-out divided by the mean population and the whole multiplied by 1000.

A transferable death is the death in England and Wales of a person who having a fixed or usual residence in England or Wales dies in a district other than that in which he resided. Transferable deaths are those occurring in general or mental hospitals or ordinary prisons. Non-transferable deaths are those of persons dying in convents, alms-houses, industrial schools, convict prisons and usually infectious diseases hospitals, and also deaths of casuals, aliens and persons having a usual residence in Scotland or Ireland.

A transferable death is the death in Scotland of a person who having a fixed or usual residence in Scotland dies in a district other than that in which he resided.

The death rate in 1945 of England and Wales was 11·4 per thousand: of Scotland 13·2 per thousand.

Standardised Death Rate.[2] This rate is a hypothetical figure showin the value of the recorded death rate when allowance is made for the ag and sex constitution of the population. Death rates are lowest at young adult ages and highest at the extremes of life. Also males have i general a higher death rate than females. A population with a hig proportion of young adults is thus at an advantage, and when an comparison of its death rate with others is being made it is proper tha the advantage which it enjoys in this particular should be discounte Two methods are employed. In one, which is termed *direct*, the se and age-group death rates of, say, the town are applied to a standar million of persons. The resulting figure is the standardised death rate per million. It will be higher if the town is at an advantage in respect of its age and sex constitution: lower if the reverse is the case. In the other method, which is termed *indirect,* the sex and age group death rates of the whole country are applied to the population of the town in such a manner as to bring out a standardising or adjusting factor. When this factor is multiplied into the recorded death rate of the town it will increase it if the town is at an advantage but reduce it if the reverse is the case. For example, in an area which is at an advantage, with recorded death rate 11·4 and standardising factor 1·2605, we get 11·4 × 1·2605 = 14·37, which is the standardised death rate. On the other hand, in an area which is at a disadvantage, 13·3 × 0·6471 gives a standarised death rate of 8·60. Of the two methods, the direct is slightly the more accurate.

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[1] In Scotland called the Corrected Death Rate.

[2] In Scotland called the Corrected and Adjusted Death Rate.

TABLE 4.

STANDARD MILLION, ENGLAND AND WALES, 1901.

	Age Groups.	Persons.	Sexes.
Males	0-5	114,262	57,039
	5-15	209,944	104,832
	15-25	195,742	94,693
	25-35	161,579	76,425
	35-45	122,849	59,394
	45-55	89,222	42,924
	55-65	59,741	27,913
	65-75	33,080	14,691
	75 and upwards	13,581	5,632
		1,000,000	
Females	0-5	114,262	57,223
	5-15	209,944	105,112
	15-25	195,742	101,049
	25-35	161,579	85,154
	35-45	122,849	63,455
	45-55	89,222	46,298
	55-65	59,741	31,828
	65-75	33,080	18,389
	75 and upwards	13,581	7,949
		1,000,000	1,000,000

Direct Method. The direct method of making allowance for age and sex distribution, as used in England and Wales, consists in applying the local age-group death rates to the national population. The Registrar General takes as his national population a million persons having the age and sex grouping of the population of England and Wales in 1901. These persons compose the Standard Million as exhibited in Table 4 for persons and sexes.

Prior to 1901 it was customary to adopt each successive census population as the standard, which involved the re-working on each occasion of all previously calculated standardised rates. This labou the stereotyped standard million method obviates.

The procedure for the direct method is set forth in Table 5 whic deals with the standardisation of the death rates of the aggregate County Boroughs of England and Wales for 1924. Part I of the Tabl relates to the standardisation of sex rates and Part II to the standardisation of persons rates.

In Part I column 2 are entered the recorded death rates for eac sex and age group per million living in the aggregated County Borough in 1924. In column 3 are noted, opposite the sexes independently, th number of persons in each age group making up the standard million

Table 5.

Death Rate Standardisation. Direct Method

Aggregated County Boroughs. England and Wales, 1924.

I. Standardisation of Sex Rates

	1. Age Groups.	2. Recorded Local Death Rates per Million Living.	3. Standard Million Population, 1901 (persons).	4. Deaths in Standard Million Population $\frac{2\times3}{1,000,000.}$
Males	0-5	30,372	114,262	3,470
	5-15	2,209	209,944	464
	15-25	3,192	195,742	625
	25-35	4,228	161,579	683
	35-45	7,358	122,849	904
	45-55	13,414	89,222	1,197
	55-65	28,733	59,741	1,717
	65-75	67,987	33,080	2,249
	75 and up	160,950	13,581	2,186
			1,000,000	13,495
Females	0-5	24,694	114,262	2,822
	5-15	2,179	209,944	457
	15-25	2,946	195,742	577
	25-35	3,687	161,579	596
	35-45	5,415	122,849	665
	45-55	9,603	89,222	857
	55-65	21,096	59,741	1,260
	65-75	52,725	33,080	1,744
	75 and up	142,291	13,581	1,932
			1,000,000	10,910

Column 4 = column 2 × column 3 ÷ 1,000,000 = the deaths for each ag group of the standard million corresponding to the recorded local deat rates. The sum of the males in column 4, 13,495 per million, is th standardised death rate (males). The sum of the females, 10,910, is th standardised death rate (females).

In Part II, columns 5 and 6 are the same as columns 1 and 2 Part. I. In column 7 are noted, opposite the component sexes, th number of persons in each age group making up the standard millio Column 8 = column 6 × column 7 ÷ 1,000,000. The sum of column taking males and females together, 12,124 per million, is the standardis death rate (persons).

Indirect Method. The indirect method of making allowance for age and sex distribution consists in applying the national age-group death rates to the local population. The procedure as employed in England is set forth in Table 6, which portrays the standardisation of the death rate of the Borough of Bedford. The national population is that of England and Wales in 1901, the same as furnished the standard million for the direct method. The standard year for the time being is 1921. The standard death rate is that of England and Wales in the standard year.

Column 2 of the Table is the age and sex grouping of the national population. Column 3 shows the standard death rates for age and sex groups in the standard year, being the mean deaths of England and Wales for 1920-22, divided by the census population, expressed per 1000 living. Column 4 = column 2 × column 3 ÷ 1000. The sum of column 4 gives the total standard or expected deaths in the standard population at standard rates. The sum of column 4 divided by the sum of column 2 × 1000 is the Index Death Rate (E. and W.). Column 5 is the population of Bedford by sex and age in the standard year. Column 6 = column 5 × column 3 ÷ 1000. The sum of column 6 gives the total standard or expected deaths in Bedford at standard rates. The sum of column 6 divided by the sum of column 5 × 1000 is the Index Death Rate (Bedford). Thus

II. Standardisation of Persons Rates

	5. Age Group.	6. Recorded Local Death Rates per Million Living.	7. Standard Million Population, 1901 (Sexes).	8. Deaths in Standard Million Population $\frac{6\times7}{1,000,000}$
Males	0-5	30,372	57,039	1,732
	5-15	2,209	104,832	232
	15-25	3,192	94,693	302
	25-35	4,228	76,425	323
	35-45	7,358	59,394	437
	45-55	13,414	42,924	576
	55-65	28,733	27,913	802
	65-75	67,987	14,691	999
	75 and up	160,950	5,632	906
Females	0-5	24,694	57,223	1,413
	5-15	2,179	105,112	229
	15-25	2,946	101,049	298
	25-35	3,687	85,154	314
	35-45	5,415	63,455	344
	45-55	9,603	46,298	445
	55-65	21,096	31,828	671
	65-75	52,725	18,389	970
	75 and up	142,291	7,949	1,131
			1,000,000	12,124

Death rate (Males) = 13,495 per million.
Death rate (Females) = 10,910 per million.
Death rate (Persons) = 12,124 per million.

$$\text{Index Death Rate (E. and W.)} = \frac{377512.2 \times 1000}{32,527,843} = 11.6058.$$

$$\text{Index Death Rate (Bedford)} = \frac{531.6 \times 1000}{40242} = 13.2101.$$

With the same age and sex distribution therefore 13·2101 deaths pe 1000 in Bedford are equivalent to 11·6058 deaths per 1000 in Englan and Wales, and 1 death per 1000 in Bedford is equivalent to 0·879 deat per 1000 in England and Wales. The figure 0·879 is the Standardisin Factor, which, when multiplied by the Bedford death rate for any yea following 1921 up to the next census, takes account of age and se distribution, and makes it comparable on equal terms with any othe death rate similarly standardised.

TABLE 6.

DEATH RATE STANDARDISATION. INDIRECT METHOD

BOROUGH OF BEDFORD

	1. Age Group.	2. Population, England and Wales, 1901.	3. Mean Death Rate, England and Wales, 1920-1922, per 1000 Living.	4. Standard Deaths, England and Waies.	5. Population, Bedford, 1921.	6. Standard Deaths, Bedford.
Males	0-	1,855,361	32.92	61,078.5	1,438	47.3
	5-	3,409,963	2.35	8,013.4	3,429	8.1
	15-	3,080,166	3.27	10,072.1	3,260	10.7
	25-	2,485,954	4.39	10,913.3	2,576	11.3
	35-	1,931,943	6.80	13,137.2	2,442	16.6
	45-	1,396,209	11.75	16,405.5	2,192	25.8
	55-	907,945	25.05	22,744.0	1,455	36.4
	65-	477,868	57.58	27,515.6	807	46.5
	75-	183,204	144.36	26,447.3	322	46.5
Females	0-	1,861,347	26.43	49,195.4	1,390	36,7
	5-	3,419,068	2.35	8,034.8	3,353	7.9
	15-	3,286,899	2.95	9,696.4	4,285	12.6
	25-	2,769,886	3.90	10,802.6	3,482	13.6
	35-	2,064,062	5.31	10,960.2	3,223	17.1
	45-	1,505,982	9.00	13,553.8	2,859	25.7
	55-	1,035,305	18.72	19,380.9	1,890	35.4
	65-	598,138	44.92	26,868.4	1,216	54.6
	75-	258,543	126.45	32,692.8	623	78.8
		32,527,843		377,512.2	40,242	531.6

Combined Death Rate. In certain circumstances it is necessary t ascertain the combined death rate in an area containing several town each of which shows a different mortality rate. In such a case th combined death rate is not the direct mean of the individual town rate but the sum of the total deaths in each town expressed as a rate per 100

If, for example, an area contains town A with population 30,000 ar death rate 10 per 1000, town B with population 58,000 and death ra 18 per 1000 and town C with population 40,000 and death rate 12 p 1000, the combined death rate is not $10 + 18 + 12 \div 3 = 13.3$, but :-

$$\left(\frac{\dfrac{30,000 \times 10}{1000} + \dfrac{58,000 \times 18}{1000} + \dfrac{40,000 \times 12}{1000}}{30,000 + 58,000 + 40,000}\right) \times 1000$$

$$= 14.25$$

OCCUPATIONAL MORTALITY

When we seek to compare the mortalities prevailing in different occupations it is essential that the death rates of the workers should be standardised for age. This procedure has been carried out for England and Wales by the Registrar General. His most recent survey, which relates to the year 1931, comprises (1) occupations of males, (2) wives of occupied males and (3) occupations of single women. The first of these subjects he had discussed on previous occasions. The second and third were new.

Males. The method adopted was to apply to the age groups between 20 and 65 of the various occupations at the census of 1931 the death rates of all occupied and retired males, including the Navy, Army and Air Force, based on the three years centring on census year. The sum of the products so obtained gave the standard number of deaths for each occupation. The percentage relationship to these standard deaths of the actual deaths recorded is the 'Standard Mortality Ratio,' lettered S.M.R. Thus for the occupation of farmer, with standard deaths 7803 and registered deaths 5693, the S.M.R. is 73. According as the S.M.R. is less or greater than 100 the health of the workers in an occupation is better or worse than the average.

TABLE 7.

OCCUPATIONAL MORTALITY

Males. Aged 20-65. All Causes. England and Wales.

OCCUPATION.	STANDARDISED MORTALITY RATIO 1931.
Clergy: Anglican	69
Agricultural Labourers	77
Clergy: Roman Catholic	105
Cotton Spinners and Piecers	105
Registered Medical Practitioners	106
Hewers and Getters	113
Gas Workers	115
Masons: Stone Cutters	121
Chimney Sweeps	136
Metal Grinders	137
Barmen	149
File Cutters	153
Inn Keepers: Publicans	155
Kiln and Oven Men: Earthenware	157
Cutlery Grinders	240
Sand Blasters	304
Tin and Copper Miners	342

Table 7 presents for males aged 20 to 65 in England and Wales the S.M.R.s of selected occupations in 1931.

The *Anglican Clergy* with S.M.R. 69 head the list as exceptionally healthy, their only mortality above the average being from angina pectoris. *Agricultural Labourers* with S.M.R. 77 had also a favourable experience, their sole excess record being due to deaths from hernia. The *Roman Catholic Clergy* with S.M.R. 105, who were slightly over the general average, had a rather high mortality from nephritis. *Cotton Spinners and Piecers*, also with S.M.R. 105, had a high death rate at young ages. They showed excess rates for bronchitis and diabetes, and some excess for cancer, which is a disease of mule spinners. The fatal cases of scrotal cancer among mule spinners numbered 43.

Registered Medical Practitioners with S.M.R. 106 showed a high mortality from angina pectoris and an excess for digestive diseases and appendicitis. Pneumonia also figures as a fatality of doctors.

Hewers and Getters of coal had the S.M.R. 113. They suffered, in the aggregate, excess death rates from sepsis, cancer and chronic interstitial pneumonia, with much variation between different coal fields. They shared the highest fatal accident rates with railway pointsmen, shunters, stevedores and merchant seamen. Their physical make-up as a group had been deteriorating during the decade ended 1931, as the healthiest and most enterprising were turning to other occupations in consequence of the displacement of man power by the mechanical coal cutter. *Gas Workers* with S.M.R. 115 had a cancer mortality above the average. Among their 142 fatalities from this disease 23, which involved the larynx or lung, exemplified the carcinogenic activity of volatile coal tar products.

Masons and stonecutters, dressers and carvers, with an aggregate S.M.R. of 121, worked in an atmosphere charged with the stone dust created by their chisels. Hence their high mortality from chronic interstitial pneumonia and pulmonary tuberculosis. Not all groups however were equally affected. In sandstone workers who inhaled the lethal siliceous dust the S.M.R. was 180. In limestone workers, not exposed to this hazard, the S.M.R. was 98. *Chimney Sweeps* with S.M.R. 136 experienced a high death rate from respiratory conditions comprising tuberculosis, bronchitis and pneumonia. Their 108 deaths from cancer were much above the average, the scrotum being the part affected in 15 cases. *Metal Grinders* with S.M.R. 137 improved their health position in the decade prior to 1931. Originally they had ground their edge tools on dry gritstone wheels, filling the air with a dust of silica which produced in the workers a phthisis death rate four times the average, but the increasing use for the wheels of the innocuous emery Al_2O_3 and carborundum SiC in lieu of gritstone did much to reduce the silica hazard. Nevertheless the grinders at older ages still revealed in 1931 excess mortality from bronchitis, pneumonia, silicosis, tuberculosis and cancer of the lung.

Barmen with S.M.R. 149 presented mortalities above the average for phthisis, cirrhosis of the liver, nephritis and gastric ulcer. Their cancer deaths also were in excess, the mouth, throat, oesophagus, larynx and prostate being greatly affected. *File Cutters* with S.M.R. 153 worked either by hand or with a machine. In cutting by hand the file is strapped to a lead cushion, from which in the past lead poisoning had been contracted. The cutters in 1931 showed excess deaths from a number of causes, but no death was attributable to the action of lead. *Inn Keepers* *and Publicans* with S.M.R. 155 suffered from excess mortality in all age groups. Their highest fatality rates were from acute alcoholism and liver cirrhosis. Other causes of death in marked excess were nephritis, digestive diseases, suicide and cancer, the last chiefly located in the mouth, larynx and oesophagus.

Kiln and Oven Men with S.M.R. 157, who were employed in the manufacture of earthenware and china, were subject to lead risk from the glazes and to silica risk from the flint dust in which the ware is packed. The decade ending in 1931 had witnessed salutary improvements with consequent decline of the previous high death rates from silicosis and pulmonary tuberculosis. But in the interval the cancer rate appears to have increased. Kiln and oven men who manufactured bricks and unglazed tiles exhibited no important excess mortality and their S.M.R. was only 87.

Cutlery Grinders had the S.M.R. 240. This figure, though still high, is a marked reduction on previous records. Most of the gritstone wheels in Sheffield and Birmingham have made way for emery or carborundum, but sufficient time has not yet elapsed for the good effects of the change over to become fully apparent. *Sand Blasters* with S.M.R. 304 were exposed to grave risk from silica. Their work is to direct a jet charged with sand, steel shot or other abrasive upon steel castings to clear them of sand or upon glass to etch a pattern. *Tin and Copper miners* with S.M.R. 342 had the worst record of all. Their risk was from the siliceous dust freed by drilling and blasting the quartz rock which encloses the metalliferous veins.

TABLE 8.

OCCUPATIONAL MORTALITY

Wives. Aged 20—65. All Causes. England and Wales.

OCCUPATION OF HUSBANDS.	STANDARDISED MORTALITY RATIO 1931. WIVES.
Clergy: Anglican	85
Agricultural Labourers	88
Cotton Spinners and Piecers	124
Registered Medical Practitioners	79
Hewers and Getters	140
Masons: Stone Cutters	107
Chimney Sweeps	119
Barmen	109
Inn Keepers: Publicans	117

Merchant Seamen. The health data for merchant seamen are less complete than for other occupations, but on information derived from various sources their S.M.R. emerges as 147. The mortality rate of seamen for 'violence' was double the average. Omitting violence, their standardised mortality was 36 per cent. in excess.

Wives. Health damage to men operatives may be inflicted directly, that is to say, through exposure to risk while working in the factory, or indirectly, through inferior living conditions imposed on the worker's home by the character of his trade. An indication of the respective activities of these two influences may be obtained from a study of the mortality prevailing among the wives of the men workers. While such a study means more than the mere collation of the S.M.R.s of husband and wife, it may be said broadly that where the wife's S.M.R. falls much short of the husband's the chances are that the husband's health damage from his trade was inflicted directly.

Table 8 exhibits for the wives of men employed in a number of the occupations listed in Table 7, their S.M.R.s classified according to the occupations of their husbands.

Anglican Clergy. Husbands 69. Wives 85. The S.M.R. is greater for the wives, who had excess of breast cancer. *Agricultural Labourers.* Husbands 77. Wives 88. The S.M.R. of wives is the higher. They presented a significant excess of deaths from maternal diseases. *Cotton Spinners and Piecers.* Husbands 105. Wives 124. Among the wives there was excess mortality from heart disease and cancer, but a number were employed in textile mills.

Registered Medical Practitioners. Husbands 106. Wives 79. The higher S.M.R. for husbands suggests direct occupational influence.

Hewers and Getters. Husbands 113. Wives 140. The wives exhibited excess mortality from almost every cause. Though the husbands' S.M.R. was the lower, their deaths from sepsis, silicosis and accident must be reckoned directly occupational. *Masons and Stone Cutters.* Husbands 121. Wives 107. The S.M.R. for wives was substantially the lower and their mortality from respiratory diseases did not exceed the normal. The silicosis, pneumonia and pulmonary tuberculosis to which their husbands succumbed were due to direct occupational influence. *Chimney Sweeps.* Husbands 136. Wives 119. Cancer mortality helped to raise the S.M.R. of the husbands. For them it was a direct occupational hazard, shared however with their wives, whose cancer rate was also high.

Barmen. Husbands 149. Wives 109. The high S.M.R. for husbands was mainly due to the risks of their calling, which operated directly upon them. The wives were nearly normal, showing only some slight excess for heart disease and liver cirrhosis and no deaths from cancer. *Inn Keepers.* Husbands 155. Wives 117. The husbands' risks were direct as in the case of barmen, but more serious. The wives' S.M.R., though lower than the husbands', was accompanied by excess mortality from liver cirrhosis, nephritis and suicide.

Single Women. The standardised mortality ratios for occupations of single women were calculated on the same plan as for males, the death rates of all single women giving the average.

Table 9 presents for single women age 20 to 65 in England and Wales the S.M.R.s of selected occupations in 1931.

Telephone Operators with S.M.R. 45 had the lowest mortality of all occupations engaged in by single women. *Telegraph Operators* with S.M.R. 48 were a good second. *Typists and Clerkesses* with S.M.R. 68

had a low phthisis mortality at all ages. *Midwives and Nurses* with S.M.R. 78 showed a slight excess of deaths from septic infections. *Actresses and Musicians* had S.M.R. 87. Their suicide rate was noted as probably a significant excess. *Barmaids* with S.M.R. 90 presented a much better health picture than barmen with S.M.R. 149. For *Domestic Servants* the S.M.R. was 106, a little above the average. At the earlier ages they were free of fatal illness, excepting the infections. At later ages they experienced excess of deaths from cancer, heart disease and other causes. Among *Nuns* with S.M.R. 111 there was a high mortality rate from respiratory tuberculosis. *French Polishers* with S.M.R. 116 suffered in the same way as nuns. *Inn keepers.* Single women keeping inns, hotels or public houses had S.M.R. 117, the same figure as the wives of men engaged in these occupations. For the men themselves the S.M.R. had been 155. *Charwomen* with S.M.R. 126 had excess deaths from arteriosclerosis, cancer and accidents. *Costermongers and Hawkers* had the high S.M.R. of 200, made up of excess mortalities from almost all the causes investigated, including cancer.

TABLE 9.

OCCUPATIONAL MORTALITY

Single Women. Aged 20—65. All Causes. England and Wales.

OCCUPATION.	STANDARDISED MORTALITY RATIO 1931.
Telephone Operators	45
Telegraph Operators	48
Typists: Clerkesses	68
Shop Assistants	77
Midwives: Nurses for the Sick	78
Actresses: Musicians	87
Barmaids	90
Domestic Servants	106
Nuns	111
French Polishers	116
Pottery Dippers	116
Inn Keepers	117
Charwomen	126
Milliners: Hat Formers	133
Costermongers: Hawkers	200

Another device which makes allowance for the age-group make-up of the workers in occupations is the ‘Comparative Mortality Figure,’ lettered C.M.F. It is based upon a standard population. According as the C.M.F. is less or greater than 1000 the health of the workers in an occupation is better or worse than the average. The C.M.F. usually equals, or approximates to, ten times the S.M.R. As an example of equality, for the occupation of boiler maker the S.M.R. is 113 and the C.M.F. 1130. As an example of approximation, for the occupation of metal grinder the S.M.R. is 137 and the C.M.F. 1410.

Occupational mortality should be interpreted on all the relevant facts. Some occupations are only suited to men of exceptional physique, who are drafted in at first by selective recruitment, the standard of personnel being maintained thereafter by selective discharge or transfer of the unfit to less exacting work. Other occupations, calling for judgment or vigilance, need men of a good type all round, to whom the same principles of selection apply. Under such conditions if the S.M.R. is low it is sometimes not easy to decide how much of the credit is due to the work and how much to the character of the worker. A man's work means more than the load he lifts: it takes in the mental and ethical standards of his trade, his economic position, his use of leisure, and other factors. Broadly regarded these personal and other circumstances may be admitted as pertinent to his occupation. Whether or not, their effects are represented in its mortality returns.

LIFE TABLES

A life table, also called a mortality table, is a form of statistical computation which represents the march through time of a hypothetical company of persons who are necessarily subject to the living conditions prevalent during their march. Beginning with say 100,000 or 1,000,000 the numbers are observed to diminish progressively year by year as death thins the ranks, till only a few aged people are left and finally all are dead. Taking the numbers alive in each successive year it is possible to calculate the average number of years of life in store for people of any age from birth onwards. This is the 'complete expectation of life' usually stated for males and females separately and written $\mathring{e}_x$, where x is the year of age. $\mathring{e}_x$ has actuarial and other uses, as in the H^m and H^f tables of insurance companies. It is however in addition an excellent test of the health of a community since it is bound to reflect the vital influences of the time, providing a means of comparison between the conditions of different communities or of the same community at different epochs. In England and Wales round 1871 the expectation of life for males at birth was 41 years: round 1901 it was 48 years: round 1921 it was 55 years and round 1931 it was 58 years. As living conditions improved the expectation of life increased. The highest expectation is not necessarily that at birth. In a Scottish table cited below the expectation for males was 53 years at birth but higher for all subsequent ages up to and including 10. It should be kept in mind that the expectation of life calculated in this manner is an average quantity and does not imply that any individual of a given age can count upon living the number of years computed for his age.

Table 10 reproduces a page of a Scottish Life Table appropriate to the year 1921.[1] The Table is founded upon the population statistics of Scotland in the year 1921 as brought out in the census of that date, and upon the deaths registered during the years 1920 to 1922.

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[1] Scottish Life Tables, 1921, by James Craufurd Dunlop, M.D., Registrar General for Scotland. Transactions of the Faculty of Actuaries. Vol. 10, Part I., 1924.

Table 10.

Scottish Life Tables, 1921

Life Table No. I.—Males. Page 1

Age x	l_x	d_x	q_x	T_x	$\mathring{e}_x$
0	100,000	10,597	·1059739	5,308,259	53·08
1	89,403	2,757	·0308347	5,216,410	58·35
2	86,646	1,182	·0136360	5,128,385	59·19
3	85,464	633	·0074070	5,042,330	59·00
4	84,831	416	·0049097	4,957,183	58·44
5	84,415	364	·0043125	4,872,560	57·72
6	84,051	291	·0034605	4,788,327	56·97
7	83,760	233	·0027864	4,704,421	56·17
8	83,527	191	·0022900	4,620,778	55·32
9	83,336	164	·0019730	4,537,346	54·45
10	83,172	153	·0018342	4,454,092	53·55
11	83,019	156	·0018742	4,370,997	52·65
12	82,863	173	·0020930	4,288,056	51·75
13	82,690	190	·0022991	4,205,280	50·86
14	82,500	206	·0024973	4,122,685	49·97
15	82,294	221	·0026910	4,040,288	49·10
16	82,073	237	·0028821	3,958,104	48·23
17	81,836	251	·0030710	3,876,150	47·36
18	81,585	266	·0032566	3,794,439	46·51
19	81,319	279	·0034363	3,712,987	45·66
20	81,040	292	·0036074	3,631,808	44·82
21	80,748	304	·0037672	3,550,914	43·98
22	80,444	315	·0039106	3,470,318	43·14
23	80,129	324	·0040395	3,390,031	42·31
24	79,805	332	·0041611	3,310,064	41·48
25	79,473	340	·0042828	3,230,425	40·65
26	79,133	349	·0044119	3,151,122	39·82
27	78,784	358	·0045431	3,072,164	38·99
28	78,426	366	·0046715	2,993,559	38·17
29	78,060	375	·0048051	2,915,316	37·35
30	77,685	385	·0049523	2,837,443	36·52
31	77,300	396	·0051211	2,759,951	35·70
32	76,904	409	·0053163	2,682,849	34·89
33	76,495	423	·0055324	2,606,149	34·07
34	76,072	438	·0057630	2,529,866	33·26
35	75,634	454	·0060012	2,454,013	32·45
36	75,180	469	·0062405	2,378,606	31·64
37	74,711	483	·0064642	2,303,660	30·83
38	74,228	496	·0066768	2,229,191	30·03
39	73,732	509	·0069031	2,155,211	29·23
40	73,223	525	·0071683	2,081,733	28·43
41	72,698	545	·0074979	2,008,773	27·63
42	72,153	569	·0078929	1,936,347	26·84
43	71,584	597	·0083372	1,864,479	26·05
44	70,987	627	·0088305	1,793,193	25·26

As the census returns do not give directly the numbers of persons attaining precise ages, the observed numbers of living and dying must be replaced by calculated numbers. The first step is to ascertain for each year of age the ratios between the recorded deaths and the recorded population. These ratios are called the Central Death Rates and are represented by the symbol m_x.[1] The Central Death Rates for all years of life being ascertained, the next step is to calculate the rate q_x, known as the Rate of Mortality, which is the probability that a person of exact age x will die within one year following the attainment of that age.

The Rate of Mortality q_x is an all-important factor in the construction of Life Tables as on it depends the construction of column l_x, shown in Table 10, which indicates the exact numbers attaining each particular year of life, and also the construction of all other columns dependent on that column. The rate q_x is obtained from m_x on the assumption that deaths between ages x and $x+1$ are uniformly distributed throughout the year. This assumption implies that the mean population between exact age x and exact age $x+1$ equals $l_x - \frac{1}{2}d_x$, that is to say, the number attaining age x minus half the number of deaths occurring between ages x and $x+1$. Hence

$$m_x = \frac{d_x}{l_x - \frac{1}{2}d_x}$$

From this formula it can be deduced that

$$q_x = \frac{2m_x}{2+m_x}$$

So that q_x for each year of life can be calculated from m_x by multiplying m_x by 2 and dividing by $2+m_x$. Thus m_x at age 20 being found to be ·0036139, $q_{20} = \frac{\cdot 0072278}{2\cdot 0036139} = \cdot 0036074$, as shown in the Table. In practice it is necessary by mathematical means to remove accidental irregularities appearing in the q_x column on account of peculiarities of the data. This is done by a process known as Graduation. It is necessary also owing to defects of the data to adopt special means for estimating q_x at the youngest ages.

The Rate of Mortality q_x for all ages being now known, the Life Table may be drawn up. Any convenient number such as 100,000, entered in column l_x opposite age 0 represents an assumed number at birth. It is known as the Radix. From the Radix all subsequent numbers in the l_x column are calculated either by the application of q_x and the deduction of the estimated number of deaths thus found, or by applying the complement of q_x, namely $1-q_x$, known as the rate p_x, which gives directly the number surviving at age $x+1$. Thus in Table 10 l_{20}, the number attaining the exact age 20, is 81,040, and q_{20} is ·0036074. From these figures d_{20}, the number of deaths between the exact ages 20 and 21, is found to be 292, so that l_{21} is 81,040 – 292, or 80,748. In this way the whole of the columns l_x and d_x can be constructed.

---

[1] In this and other symbols used, the suffix x represents any one particular year and is replaceable by a number when any precise year is indicated. Thus m_{20} is the symbol for the Central Death Rate of year of age 20.

From column l_x a column L_x, not shown in the Table, is derived. Column L_x exhibits the number living between ages x and $x+1$ as disclosed by an enumeration of the assumed population represented in the Life Table at a certain moment of time. The calculation of L_x is on the assumption that the deaths during a year of age are equally distributed during that year, and that the mean number living during the year x to $x+1$ is the mean of the two numbers l_x and l_{x+1}. Thus $L_{20}=\frac{81040+80748}{2}=80{,}894$. The calculation of L_0 requires a special formula because deaths among children less than one year of age are not equally distributed throughout that year.

Column T_x of the Table is calculated by summing column L_x from age x to the end of the Table. It shows the number of persons aged x and upwards living at any moment of time.

Column $\mathring{e}_x$ shows the Expectation of Life, which is the average number of years of life in store after attainment of age x by each of the l_x persons who attain that age. It is derived by dividing each T_x by the corresponding l_x. Thus T_{20} of the Table being 3,631,808 and l_{20} being 81,040, $\mathring{e}_{20}$ or the Expectation of Life at age 20 is 44·82 years. It appears from the Life Table for Males, page 1 of which is shown as Table 10, that the expectation of male life in Scotland was at birth 53·08 years, at age two 59·19 years, at age thirteen 50·86 years, at age twenty-five 40·65 years and at age thirty-eight 30·03 years. At ages fifty and sixty-six, not shown in the Table, the expectations were 20·68 and 10·40 years. These expectations are all greater than in any of the three earlier Scottish Life Tables of 1871, 1891-1900 and 1911. Since 1871 the maximum expectation for males has been shifting to a younger age. In 1871 it was at age four; in 1891-1900 at age three, and in 1911 and 1921 at age two. These expectations are all better than in previous records.

Table 11 summarises the order of procedure in the construction of a Life Table.

TABLE 11.

CONSTRUCTION PROCEDURE FOR LIFE TABLE

B	AGES	$l_0=100{,}000$	$l_x \times q_x$	$\frac{2m_x}{2+m_x}$	$\frac{l_x+l_{(x+1)}\dots}{2}$	$\Sigma L_x+L_{(x+1)}$ +....to end of Table	$\frac{T_x}{l_x}$
A	x	l_x	d_x	q_x	L_x	T_x	$\mathring{e}_x$
C	0	2	3	1	7		
	1	5	6	4	11		
	2	9	10	8	15		
	3	13	14	12	This column does not appear in the Life Table.		

A. Column headings of life table. B. Derivation of headings.
C. Order of procedure for completing columns.

The *Mean Age at Death* is the average age at which death occurs in a mixed population. It is a rough datum and liable to several fallacies. For any year it is obtained by dividing the sum of the ages of those who die in the year by the number of deaths in the year.

BIOMETRICS

There is an ever-increasing need for the application of biometric methods in the assessment of systems of medical treatment, in epidemiology and in other departments of applied biology. They have a growing importance too in the planning and conduct of modern morbidity surveys and in the compilation of medical records. It is our hope that the pages which follow may be found of service as an introduction to the principles which underlie the manipulations of biometrics.

Fig. 31.—Powers Samas Key Punch.

First of all let our attention focus upon the framing and use of th numerical and other tables which are an essential feature of any statistical review, whether in the form of the annual report of a medical officer of health or in that of a contribution to a scientific journal. Tables are necessary preliminaries to the preparation of frequency distributions, histograms and other statistical forms. They should b intelligible to the reader without continual reference to the surrounding text. The general title of the table and the titles of its columns should be clearly and fully stated. The bases of any rates, whether per cent, per thousand or per million, should be shown, and the total number o observations upon which the rates were calculated should be stated. If any members of a series have been excluded for the purposes of the table, these, and the reasons for their exclusion, should be made manifest. When a table has been completed, its construction should bring out whether its message is clear and, if not, wherein the table has failed in its object.

Elaborate subjoined legends should not be required. Much may be learned of the art of table construction by reference to the statistical presentations in the reports of the Registrars General and equivalent publications.

The Mechanical Tabulation used for the last Census has now a widening vogue in morbidity and other surveys, the tabulation being effected on the Hollerith or Powers-Samas plan. In either case a 'field' card is employed for the collection of the preliminary data. Cards can be designed to cover any statistical survey. Each field, consisting of a horizontal series of figures, is separated from the next by vertical ruling. The first, or 'case' field, is a six column one, so permitting serial cases up to 999,999 to be recorded by key punch (Fig. 31). The second, or 'diagnosis' field has five columns. Diagnoses are transcribed coded in the form of figure combinations such as those of the Medical Research Council's coded list of diseases. Diagnosis in field 2 is that of the main illness only. Field 3 is a single column 'split' field dealing with Sex (M, F.), Status as to marriage (S, M, W, D.), presence or absence of

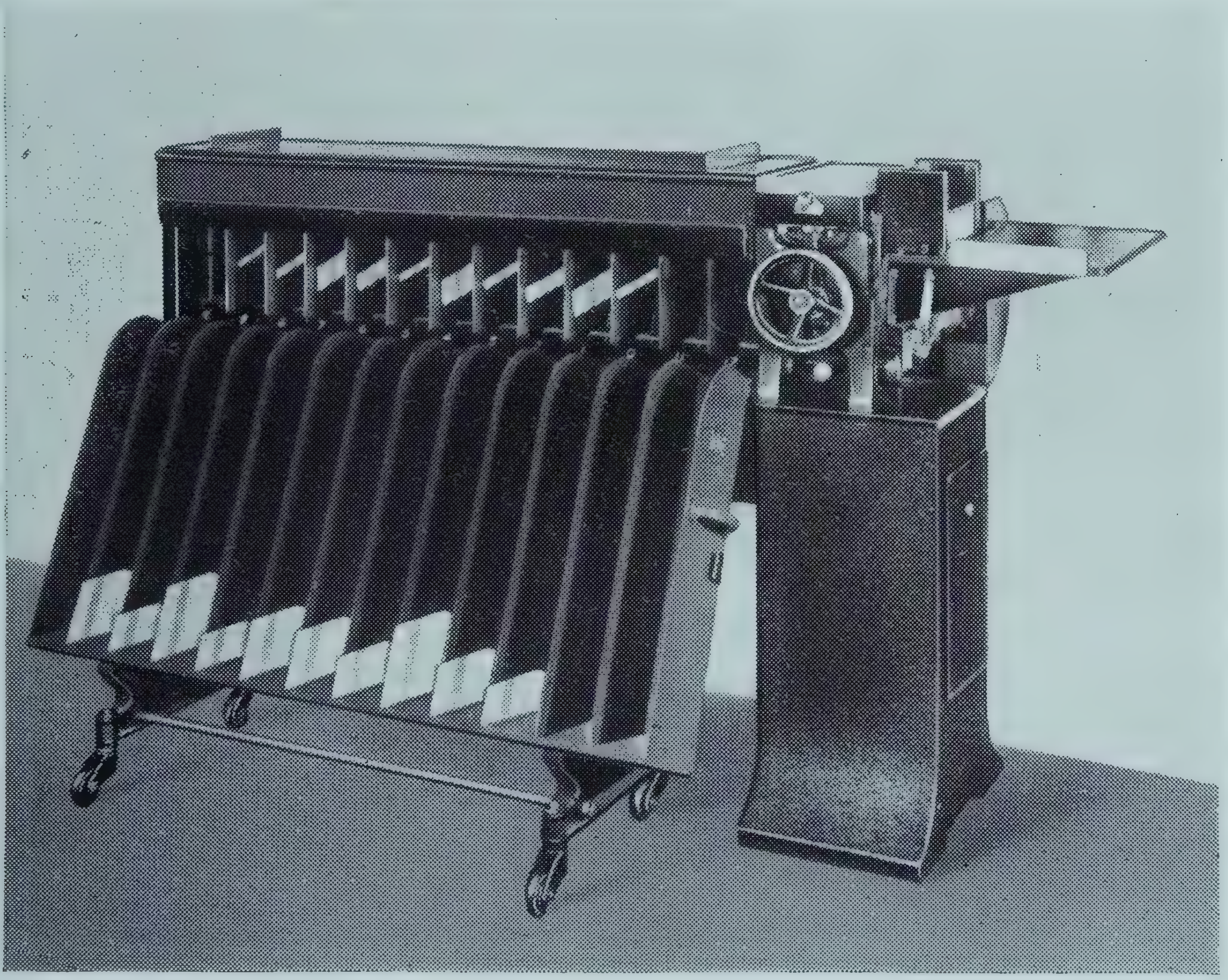


Fig. 32.—Powers Samas Mechanical Sorter.

Complication (C, N.C.) and occurrence or not of Autopsy (N.A. A). The fifth field exhibits the age of the patient, and the remaining fields up to the sixteenth and last are concerned with matters indicated by their headings. The sixteenth field is a rather complicated split field dealing with such topics as the presence of a familial history in the disease (F), previous health (Very Good, Good, Fair, Poor, Very Poor).

When the coded data have been key-punched upon the cards, the electrical 'sorter' (Fig. 32) will group them in any desired field, after which they will be counted by the electrical 'tabulator.' 'Secondary' field cards are employed to deal with complications and kindred associations of the main illness.

STATISTICAL CONSTANTS

Statistical methods have been developed to facilitate the condensation and analysis of masses of quantitative data. Condensation is necessary in order that the data may be more conveniently handled, analysis in order that the important points may be distinguished and their significance grasped. An example of a simple statistical series is presented in Table 12 which sets forth the death rates in a given year for the 16 principal towns in Scotland. The towns are arranged in the descending order of magnitude of their corrected and adjusted death rates. The salient features and significance of the series are brought out, in the manner detailed below, by the application of methods involving the use of statistical constants. These constants are of two kinds:

TABLE 12.

DEATH RATES PER 1000 IN THE 16 PRINCIPAL TOWNS IN SCOTLAND, 1926

Town.	Corrected and Adjusted Death Rate.
Glasgow	17·0
Paisley	15·6
Coatbridge	15·4
Greenock	15·0
Dundee	14·8
Hamilton	14·6
Falkirk	13·8
Edinburgh	13·7
Aberdeen	13·4
Clydebank	13·4
Kilmarnock	13·3
Motherwell and Wishaw	13·2
Kirkcaldy	12·8
Ayr	12·7
Perth	12·5
Dunfermline	11·9
16	223·1

Mean = 13·9 Median = 13·55.

(1) Centring Constants, which represent the type of the group of observed values, and (2) Dispersion Constants, which represent the degree of variation of the observed values from the type.

CENTRING CONSTANTS

Centring constants, which represent the type, are measures of medium or average value. They include the mean, the median and the mode.

Mean. In any number of observed values the mean is the sum of all the values divided by their total number. Thus, if x_1, x_2, x_3, . . . x_n be the values, n in number, of the variable x, the mean is

$$\frac{1}{n}(x_1+x_2+x_3+\ldots+x_n)=\frac{\Sigma x}{n}$$

The mean in statistics is equivalent to the arithmetical mean in algebra. It is usually denoted by $\overline{x}$.

In Table 12 the sum of the values is 223·1 and their total number is 16. The mean is $\frac{223 \cdot 1}{16}=13 \cdot 9$. While 13·9 is the mean of the death rates quoted in the table, it must not be taken as standing for the combined death rate of the 16 principal towns. To ascertain this figure it would be necessary to apply the principle of the *Weighted Mean* as follows:—

If P_1 = population of Glasgow with death rate $17 \cdot 0 = D_1$
P_2 = population of Paisley with death rate $15 \cdot 6 = D_2$
. . . .
. . . .
P_{16} = population of Dunfermline with death rate $11 \cdot 9 = D_{16}$
the death rate D of the combined population of the 16 towns would be given by the equation

$$D=\frac{P_1D_1+P_2D_2+\ldots+P_{16}D_{16}}{P_1+P_2+\ldots+P_{16}}$$

The geometric mean, which finds an occasional use in vital statistics, is derived from the formula

$$\sqrt[n]{x_1 \times x_2 \times x_3 \times \ldots \times x_n}$$

where x_1, x_2, x_3 . . . x_n are the values of the variable x.

The mean may, from imperfections of sampling and other causes, be prone to error. The reliability of the mean may readily be assessed by applying the method of standard deviation.

Median. The median is a value of the variable such that of the observed values one half lie below it and one half above it. It is the central value of the group when the values are arranged in order of magnitude. When the number of observations is even, the median is not manifest. Under this condition it is taken as the mean of two successive values. Thus in Table 12 the median is the mean of the 8th and 9th values, namely, $\frac{13 \cdot 7+13 \cdot 4}{2}=13 \cdot 55$.

Mode. The mode is, simply speaking, the most fashionable value of the variable. More accurately, it is the value of the variable which exhibits maximum frequency of occurrence.

The series of Table 12 is too small for the mode to be clearly defined.

DISPERSION CONSTANTS

Dispersion constants, which represent the degree of variation of the observed values from the type, include mean deviation, quartile deviation and standard deviation.

Mean Deviation. The mean deviation, denoted by the letter η, is the mean of the numerical values, irrespective of sign, of the deviations from the chosen average value, so that, if the deviations are d_1, d_2, d_3, . . . d_n

$$\text{Mean Deviation } \eta = \frac{\text{Total deviations}}{\text{Total frequency}} = \frac{\Sigma d}{n}$$

Thus in Table 13, which deals with the same death rates as Table 12, the mean deviations are these:
Measured from the Median, *column* 3,

$$\eta_{\text{median}} = \frac{11\cdot5 + 5\cdot2}{16} = \frac{16\cdot7}{16} = 1\cdot04$$

Measured from the Mean, *column* 4,

$$\eta_{\text{mean}} = \frac{9\cdot0 + 8\cdot3}{16} = \frac{17\cdot3}{16} = 1\cdot08$$

For any group the value of η is least when the median is the chosen average. While mean deviation is a useful measure of variability around the mean, it is less accurate than a Standard Deviation.

Quartile Deviation. The Quartile Deviation, denoted by the letter Q, measures the scatter of the values below and above the median. The middle value of the values below the median is called the Lower Quartile, Q_1 or Q_l, also 25 Percentile, P_{25}. The middle value of the values above the median is called the Upper Quartile, Q_2 or Q_u, also 75 Percentile, P_{75}. According as these two quantities are close together or far apart the distribution is narrow or wide. This can be stated adequately in terms of the Quartile Deviation, which is half the difference between the two quartiles.

Thus in Table 13

$$Q_2 = \frac{15\cdot0 + 14\cdot8}{2} = 14\cdot9$$

$$Q_1 = \frac{13\cdot2 + 12\cdot8}{2} = 13\cdot0$$

$$Q = \tfrac{1}{2}(14\cdot9 - 13\cdot0) = 0\cdot9.$$

Within the quartiles 50 per cent. of the values lie. In an ideal symmetrical distribution the median is midway between the lower and upper quartiles.

TABLE 13.

DEATH RATES PER 1000 OF THE 16 PRINCIPAL TOWNS IN SCOTLAND, 1926

1. Town.	2. Corrected and Adjusted Death Rate.	3. Deviation from Median.		4. Deviation from Mean.		5. Deviation from Mean Squared.
		+	—	+	—	
Glasgow	17·0	3·45		3·1		9·61
Paisley	15·6	2·05		1·7		2·89
Coatbridge . . .	15·4	1·85		1·5		2·25
Greenock . . .	15·0	1·45		1·1		1·21
Dundee . . .	14·8	1·25		0·9		0·81
Hamilton . . .	14·6	1·05		0·7		0·49
Falkirk . . .	13·8	0·25			0·1	0·01
Edinburgh . . .	13·7	0·15			0·2	0·04
Aberdeen . . .	13·4		0·15		0·5	0·25
Clydebank . . .	13·4		0·15		0·5	0·25
Kilmarnock . . .	13·3		0·25		0·6	0·36
Motherwell and Wishaw	13·2		0·35		0·7	0·49
Kirkcaldy . . .	12·8		0·75		1·1	1·21
Ayr	12·7		0·85		1·2	1·44
Perth	12·5		1·05		1·4	1·96
Dunfermline . . .	11·9		1·65		2·0	4·0
Totals . .	223·1	11·5+5·2 =16·7		9·0+8·3 =17·3		27·27
	Median = 13·55	$\underset{\text{median}}{\eta} = 1{\cdot}04$				
16	Mean = 13·9			$\underset{\text{mean}}{\eta} = 1{\cdot}08$		$\sigma = 1{\cdot}3$

Standard Deviation. The standard deviation, or root-mean-square deviation from the mean, is based upon the squares of the deviations from the mean, instead of the first powers of the deviations from the mean as in the Mean Deviation. In this way the larger deviations are allowed proportionately greater weight. All deviations are squared, summed and divided by their total number. The square root of this mean-square value is the standard deviation, designated by σ, and also by S.D. It is a measure of the scatter of a series of observations around their mean.

If $d_1, d_2, d_3, \ldots, d_n$ are the deviations from the mean of a series of n observations

$$\sigma = \sqrt{\left(\frac{d_1^2 + d_2^2 + d_3^2 + \ldots + d_n^2}{n}\right)}$$

$$= \sqrt{\frac{\Sigma d^2}{n}}$$

In Table 13 the squared deviations are entered in column 5. Their sum is 27·27. Therefore

$$\sigma = \sqrt{\frac{27\cdot27}{16}} = \frac{5\cdot22}{4} = 1\cdot3.$$

When the magnitude of σ is great, a widely spread frequency of the variable is indicated. A low value for σ denotes a close concentration of the frequencies around the mean.

Where the number of observations is less than 30, the standard deviation should be corrected by applying the formula $\sqrt{\frac{n}{n-1}}$, where n is the number of observations. Thus, from the example,

$$\sigma = 1{\cdot}3 \times \sqrt{\frac{16}{15}} = 1{\cdot}3 \times 1{\cdot}03$$
$$= 1{\cdot}34.$$

Coefficient of Variation. This measure of relative dispersion or variability is denoted by the letter V, and defined as 100 times the ratio of the standard deviation to the mean: so that

$$V = \frac{100\sigma}{\bar{x}}$$

From Table 13 $$V = \frac{100 \times 1{\cdot}3}{13{\cdot}9} = 9{\cdot}35$$

The coefficient of variation enables comparisons to be made between variability in different statistical series, and in series dealing with different kinds of data. Values for V must however always be interpreted with caution.

Measures of variability find a practical application in clinical medicine, as for example in the assessment of range of pulse rate and blood pressure, and in epidemiology, where the range of an incubation period may be of significance in instituting measures for infection control. It is not sufficient in such cases to know merely the mean value. It is necessary also to determine whether the observations are symmetrically or asymmetrically scattered round the mean: and whether more values are concentrated at the upper or lower limit of the series.

Table 14 exhibits the relative variabilities of 3 physical and 6 chemical

TABLE 14.

RELATIVE VARIABILITIES OF THE PHYSICAL AND CHEMICAL CHARACTERS OF THE MILK OF COWS. (J. F. TOCHER)

Coefficients of Variation, V

Character.	Mean.	σ	V.
PHYSICAL—			
Freezing-point	0·5442	0·0153	2·81
Refractive index	19·495	0·8622	4·42
Specific gravity	31·528	1·5636	4·96
CHEMICAL—			
Percentage solids-not-fat . .	8·804	0·4422	5·02
Percentage ash	0·700	0·0505	7·21
Percentage lactose	4·535	0·3712	8·01
Percentage total nitrogen . .	0·508	0·0621	12·22
Percentage casein nitrogen . .	0·380	0·0520	13·68
Percentage fat	3·953	0·7810	19·76

characters of the milk of cows. It is revealed by an inspection of the column headed V that the physical characters have a lower variability than the chemical characters. Of the chemical characters the percentage of solids-not-fat has the least variability and the percentage of fat the greatest.

GROUPED FREQUENCY DISTRIBUTION

Tabulation

The statistical constants of a series are readily calculated when the number of observations is small. When the number of observations is large, as is often the case, it becomes necessary to adopt a method for condensing the data in order that they may, as indicated above, be more conveniently handled. The grouped frequency distribution is a method of this kind. It is a tabulation showing the frequency with which events happen in particular ways. It is composed not of individual values but of values arranged in groups or classes. The upper and lower limits of the distribution are determined from an inspection of the data. When the classes have been fixed the number of values falling within each successive class interval can be written down. A grouped frequency distribution may therefore afford a concise and readily comprehensible summary of a large and complex series. Table 15 is an example. It sets forth the distribution of solids-not-fat percentages in 676 samples of milk in 16 classes with class intervals varying successively by 0·25 per cent.

Class Intervals

The values assigned to any class should be capable of being treated, without gross error, as concentrated at the mid-value of the class. Thus in Table 15 the 111 samples with values falling between 8·25 and 8·50 may all be represented by 8·375, the mid-value of the class. Subject to this condition class intervals should be as large as possible. If the number of values in the complete group is about 1000 or greater, the class intervals will usually be found sufficiently large if the total number of classes lies between 15 and 25. The size is given by the range of the distribution divided by the intended number of class intervals. In Table

$$\frac{10\cdot 75 - 6\cdot 75}{15} \doteqdot 0\cdot 26$$

Actually 0·25 was taken as the class interval for 16 classes.

TABLE 15.

GROUPED FREQUENCY DISTRIBUTION

Solids-not-Fat Percentages in 676 Samples of Milk properly drawn from 676 Individual Cows taken at random throughout Scotland

Classes = 16. Class interval = 0·25 per cent.

Solids-not-Fat Percentage.	Frequency.
6·75-	1
7·00-	...
7·25-	...
7·50-	5
7·75-	6
8·00-	44
8·25-	111
8·50-	150
8·75-	156
9·00-	110
9·25-	52
9·50-	19
9·75-	15
10·00-	4
10·25-	2
10·50-10·75	1
	676

Class intervals should, when it is possible, be so located that either their limits or mid-values are integers. Where values tend to cluster about round numbers these should be made the mid-values of intervals. In the census returns the concentration of ages is round multiples of 10. Under these circumstances 25-35 gives a better age-grouping than 20-30 or 30-40 and tabulations are made accordingly.

Class intervals should be clearly defined to obviate uncertainty as to their range. In Table 15 '8·25-' means 'from 8·25 to 8·50 including the lower but excluding the upper limit.'

Class intervals should be uniform throughout a series so that all the classes may be comparable. This rule is frequently departed from in official statistical publications, in which such age groupings as the following occur:—

—1, 1-, 5-, 10-, 15-, 25-, 35-, 45-, 55,- 65-, 75-, 85-. Care must be taken, in using a table based on the above age-groupings, that unequal classes, such as 10-15 and 15-25 are not compared on equal terms. Indeterminate classes such as '55 and over' should not be included in a series. If the last interval is closed, its upper limit should always be inserted in the table.

Constants

In order to determine the statistical constants of a grouped frequency distribution, and so measure the features of its variations, use may be made of 'moments,' which give the *mean* and the *standard deviation*. Th *median* may be ascertained by interpolation. From the mean and th median the *mode* and the *skewness* may be worked out.

The moment of a class is the distance X of the mid-value of th class interval from the point of origin multiplied by the frequency f of the class. The point of origin is arbitrarily chosen, so as to be in the neighbourhood of the mean. If N is the total number of observations

fX = First Moment of a class.
$\Sigma(fX)$ = First Moment of the distribution.
$\frac{\Sigma(fX)}{N}$ = First Moment Coefficient $= \nu_1$

fX^2 = Second Moment of a class.
$\Sigma(fX^2)$ = Second Moment of the distribution.
$\frac{\Sigma(fX^2)}{N}$ = Second Moment Coefficient $= \nu_2$

Mean. The mean is obtained from the first moment. The first moment coefficient about any arbitrary origin is the deviation of the mean from that origin. If $\nu_1 =$ first moment coefficient in class-interval units, and $n =$ number of units of measurement in each class interval, then $n\nu_1 =$ deviation of mean from arbitrary origin in units of measurement.

If then $V_0 =$ value of the variable at the arbitrary origin, mean $= V_0 + n\nu_1$.

Standard Deviation. The standard deviation is obtained from the first and second moments. If $\mu_2 =$ second moment coefficient about mean, then $\mu_2 = \nu_2 - \nu_1^2$, which gives the second moment coefficient about the mean in terms of moment coefficients about the arbitrary origin. In grouped frequency distributions, as already noted, the values assigned to any class are, as an approximation, taken as concentrated at its mid-value. To reduce the discrepancy resulting through this assumption, Sheppard's correction is sometimes applied to μ_2, giving $\mu_2 = \nu_2 - \nu_1^2 - \frac{1}{12}$, if the class-interval is the unit. The standard deviation $\sigma = \sqrt{\mu_2}$.

Calculation

The method of arranging a grouped frequency distribution with a view to the calculation of its statistical constants is presented in Table 16, Column 1 of the table repeats the solids-not-fat percentages of Table 15, Column 2 shows the class centres of the distribution. The class centre 8·625 is the arbitrary origin. Column 3 reveals the deviation X in class-interval units of each class centre from the arbitrary origin. For the class centre first occurring in the column, namely 6·875, the deviation is $-7 = (6{\cdot}875 - 8{\cdot}625) \div 0{\cdot}25$, being the difference between the two class centres divided by the class interval. Column 4 repeats the frequencies of Table 15. The sum of column 4 is N. Column 5, which is frequency (Column 4) multiplied by deviation (Column 3), is the column of first moments. Its sum, $\Sigma(fX)$, is the first moment of the distribution. Column 6, which is frequency (Column 4) multiplied by deviation (Column 3) squared, is the column of second moments. Its sum, $\Sigma(fX^2)$, is the second moment of the distribution.

By N, $\Sigma(fX)$ and $\Sigma(fX^2)$ the values of ν_1 and ν_2 are given: thus

$$\nu_1 = \frac{\Sigma(fX)}{N} = \frac{485}{676} = 0{\cdot}717456.$$

$$\nu_2 = \frac{\Sigma(fX^2)}{N} = \frac{2519}{676} = 3{\cdot}726332.$$

TABLE 16.

GROUPED FREQUENCY DISTRIBUTION

Solids-not-Fat Percentages of Table
Arrangement for Calculation of Constants

1. Solids-not-Fat Percentage	2. Class Centre	3. Deviation from Arbitrary Origin X	4. Frequency f	5. First Moment fX	6. Second Moment fX^2
6·75-	6·875	—7	1	—7	49
7·00-	7·125	—6	...	...	...
7·25-	7·375	—5	...	...	...
7·50-	7·625	—4	5	—20	80
7·75-	7·875	—3	6	—18	54
8·00-	8·125	—2	44	—88	176
8·25-	8·375	—1	111	—111	111
8·50-	8·625	0	150	0	0
8·75-	8·875	1	156	156	156
9·00-	9·125	2	110	220	440
9·25-	9·375	3	52	156	468
9·50-	9·625	4	19	76	304
9·75-	9·875	5	15	75	375
10·00-	10·125	6	4	24	144
10·25-	10·375	7	2	14	98
10·50-10·75	10·625	8	1	8	64
			676	+729 —244	2519
				+485	
			N	$\Sigma(fX)$	$\Sigma(fX^2)$

Mean

$$\text{Mean} = V_0 + n\nu_1 = 8{\cdot}625 + (0{\cdot}25 \times 0{\cdot}717456)$$
$$= 8{\cdot}80$$

Standard Deviation

$$\mu_2 = \nu_2 - \nu_1^2 = 3{\cdot}726332 - 0{\cdot}514743$$
$$= 3{\cdot}211589, \text{ and, with Sheppard's correction,}$$
$$= 3{\cdot}211589 - 0{\cdot}083333$$
$$= 3{\cdot}128256$$
$$\therefore \sqrt{\mu_2} = 1{\cdot}7687 \text{ class intervals}$$
$$= 1{\cdot}7687 \times 0{\cdot}25 \text{ units of measurement}$$
$$= 0{\cdot}44 = \sigma$$

Median

Half total frequency	338
Frequency under 8·75-	317
Difference	21
Frequency in 8·75-	156

$$\therefore \text{ Median} = 8{\cdot}75 + \frac{21}{156} \text{ class interval}$$
$$= 8{\cdot}75 + (0{\cdot}135 \times 0{\cdot}25) \text{ units of measurement}$$
$$= 8{\cdot}78$$

Mode

$$\text{Mode} = \text{mean} - 3 \ (\text{mean} - \text{median})$$
$$= 8{\cdot}8044 - 3(8{\cdot}8044 - 8{\cdot}7836)$$
$$= 8{\cdot}8044 - 0{\cdot}06225 - 8{\cdot}74$$

GRAPHICAL PRESENTATION

I. CONTINUOUS VARIABLES

Graphs

A graph is a representation of point values, the positions of which in space are quantitatively defined by a system of co-ordinates, most commonly rectangular (Fig. 33). The horizontal or x axis is termed the abscissa. The vertical or y axis is the ordinate. The distance from o to the vertical projection of the point p on the abscissal axis is the abscissa of p. The horizontal projection of p on the ordinate axis is the ordinate of p. It is customary when plotting values on rectangular co-ordinates to mark off classes on the abscissal and frequencies on the ordinate axes respectively.

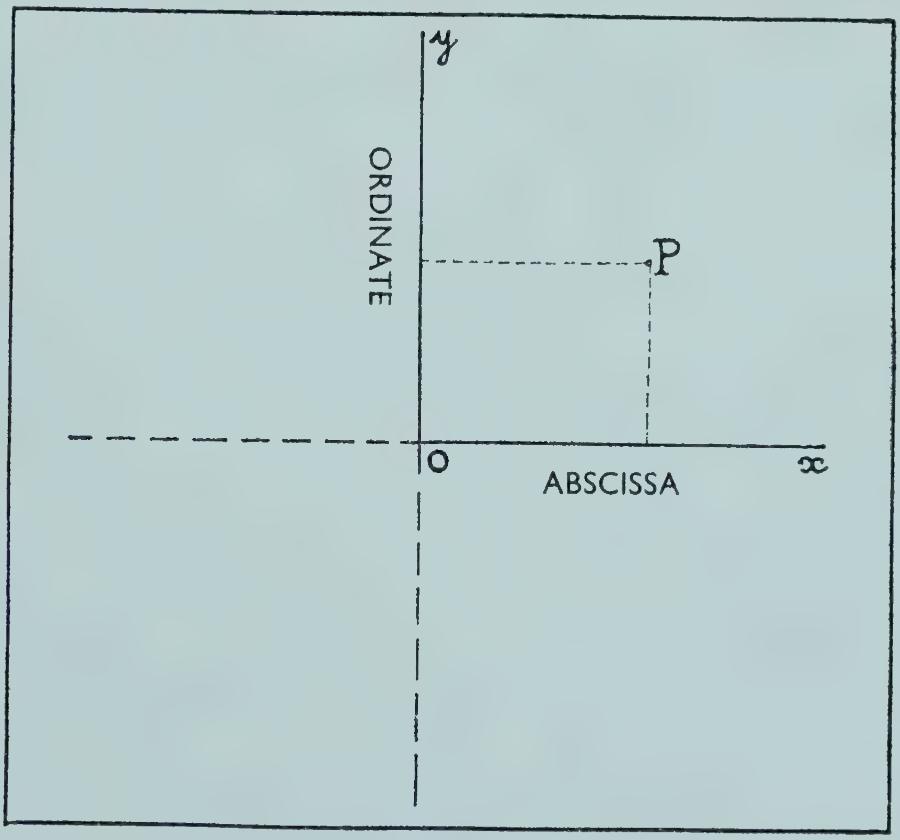
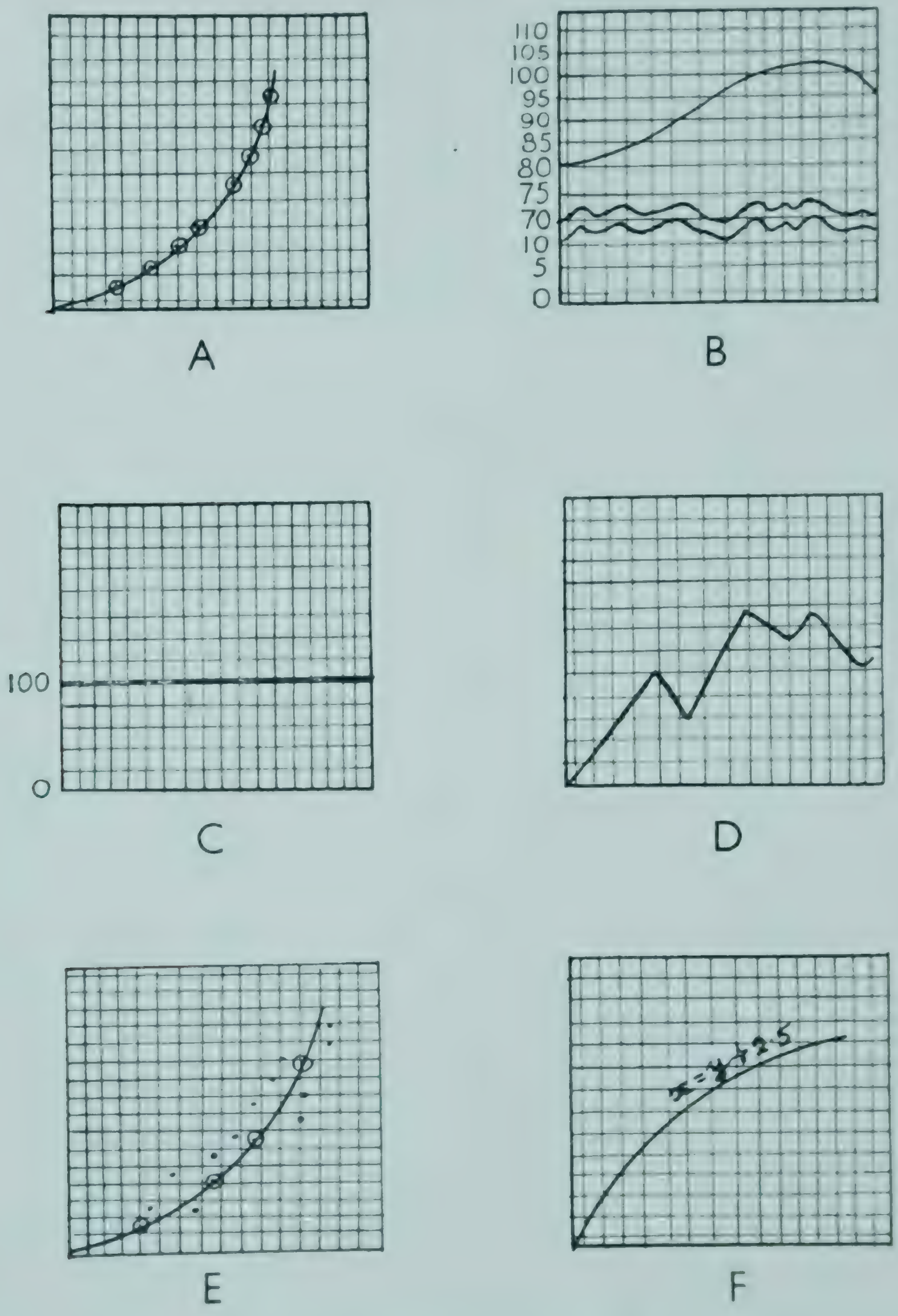


Fig. 33.—Co-ordinates of Graph.

The general arrangement of a graph should be such that the curve proceeds from left to right, and point values should be clearly indicated. (Fig. 34 (A)). The zero line should always be shown. When the zero will not normally appear in relation to the curve, its position may be given by a broken diagram (Fig. 34 (B)). Zero, base or percentage lines should be clearly distinguished from other ordinates, particularly abscissals (Fig. 34 (C)). The smallest practicable number of co-ordinates should be shown, when possible in ghost lines, and the actual curve should be distinct from the ordinate rulings (Fig. 34 (D)). When observations vary so sharply that the true graph would be unnecessarily complicated, the general trend may be shown as a smooth curve, but all values should be plotted (Fig. 34 (E)). Ordinate scales should read from bottom to top, and abscissal scales from left to right. When the graph has been



A B C D E F

Fig. 34.—Construction of Graphs.

constructed from a formula, this should be displayed close to the curve (Fig. 34 (F)). The title of the diagram, together with any necessary additional information, should be fully and clearly stated in a subjoined legend. Numerical data, relevant to but not included in, the graph, may be submitted in an accompanying table. It is important to select appropriate scales when constructing a graph. Scales which are unduly compressed or exaggerated may distort the plotted curve, either by steepening or by flattening, so that a misleading presentation of the data results.

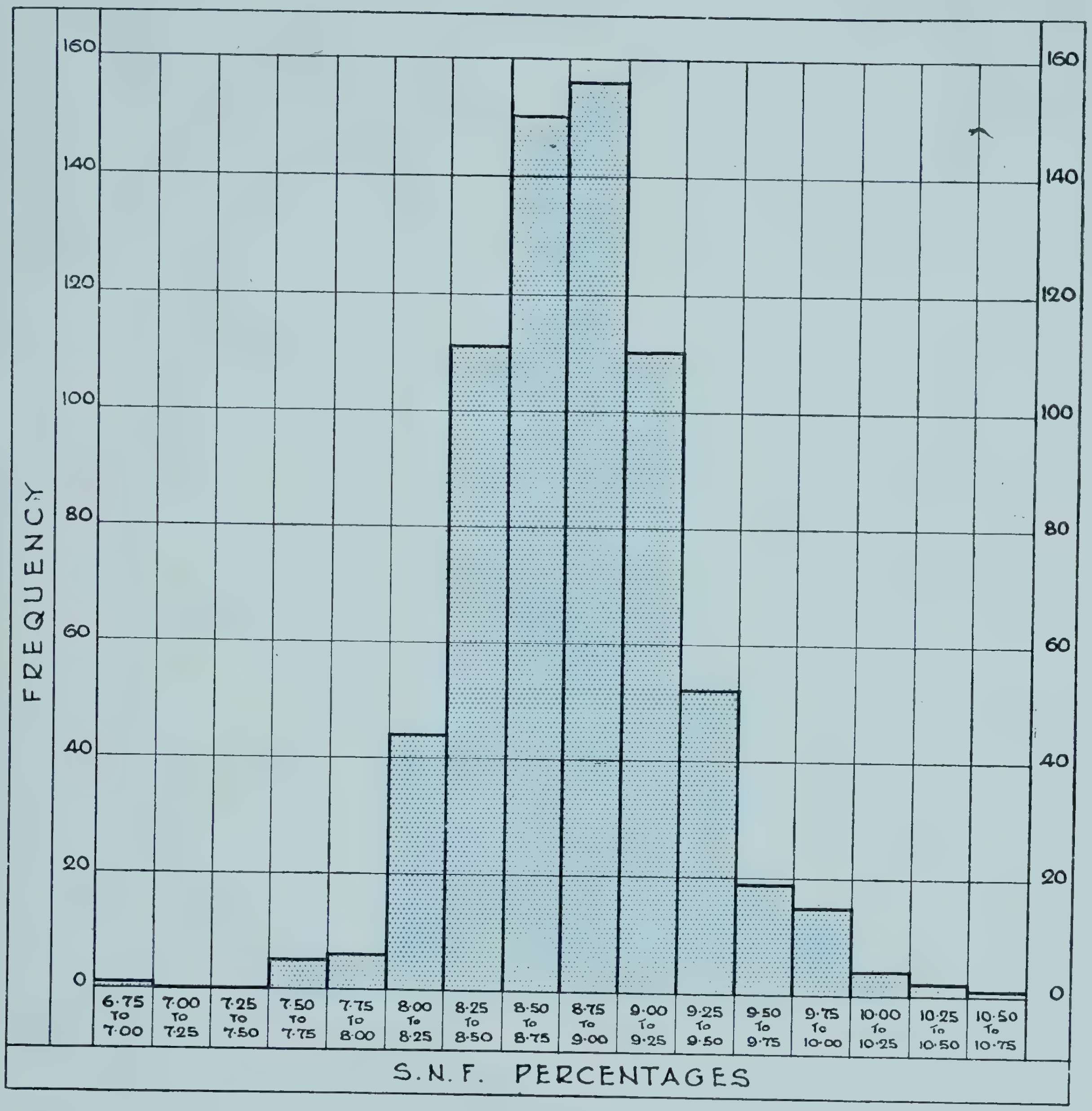


Fig. 35.—Histogram.
Solids-not-Fat Percentages in Milk, Table 17.

Histogram

For a more diagrammatic presentation of continuous variables the Histogram is often used. It is a pictorial representation by means of rectangles furnishing precisely the same information as a table of frequencies. The class intervals are laid on the abscissa or X axis, and the class frequency over each abscissal element is given by the area of the rectangle erected upon it. Figure 35 is the histogram plotted from Table 15.[1]

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[1] Page 180.

Frequency Curve

The smaller the class interval and therefore the greater the number of intervals, the smaller are the indentations in the outline of the histogram. In any practical case, reduction of the class interval beyond a certain point makes the class frequencies irregular and causes the figure to break up: but it is possible to imagine an ideal instance in which we have an unlimited number of values of a continuous variable, so that by making the class interval smaller and smaller we can make the outline practically a smooth curve. Such an ideal or theoretical limit to the histogram is called a frequency curve. Its fundamental property may be stated as follows: the area of the curve, between the ordinates corresponding to any two values of the variable, measures the corresponding number of cases in the ideal distribution represented by the curve.

The mean is the abscissa of the centroid of the area under the frequency curve.

The median is the abscissa of the ordinate which bisects that area.

The mode is the abscissa of the maximum ordinate.

If the distribution is perfectly symmetrical, mean, median and mode are equal. If the departure from symmetry is not very great it may be taken as a working rule that

$$\text{mode} = \text{mean} - 3\ (\text{mean} - \text{median}).$$

This follows from the fact that the median always lies between the mode and the mean, its difference from the former being, for such distributions, roughly twice its difference from the latter.

Skewness

Skewness (Sk), which is the measure of asymmetry, is given both in magnitude and sign by the ratio which the deviation of the mean from the mode bears to the standard deviation. By K. Pearson's formula,

$$\text{Sk} = \frac{\text{mean} - \text{mode}}{\sigma}$$

For moderately asymmetrical distributions the degree of skewness is given by the formula

$$\text{Sk} \doteq \frac{3\ (\text{mean} - \text{median})}{\sigma}$$

In symmetrical relationships, since mean = median = mode, Sk becomes zero in both formulae.

Graphically, as shown in Fig. 36, if the mode reckoned from the origin falls short of the mean, skewness is positive and the curve tails off towards high values. If the mean falls short of the mode, skewness is negative and the curve tails off towards low values.

In cases where it is difficult to locate the mode by simple methods Bowley proposes a formula based on the relationship between the quartiles and the median. If q_2 = excess of Q_2 over median and q_1 = excess of median over Q_1

$$\mathrm{Sk} = \frac{q_2 - q_1}{q_2 + q_1}$$

With perfect symmetry $q_2 = q_1$. With skewness so marked that the median coincides with one or other quartile either q_2 or q_1 becomes zero. Thus the value ranges between zero and ± 1. Bowley suggests 0·1 as the measure of moderate skewness and 0·3 of marked skewness.

It should be noted that Pearson's and Bowley's values are not comparable with one another.

The term kurtosis was applied by Pearson to the condition of the variability curve in the region of the mode as compared with the normal or Gaussian curve. Platykurtic curves are less peaked and leptokurtic curves more peaked than is the normal curve.

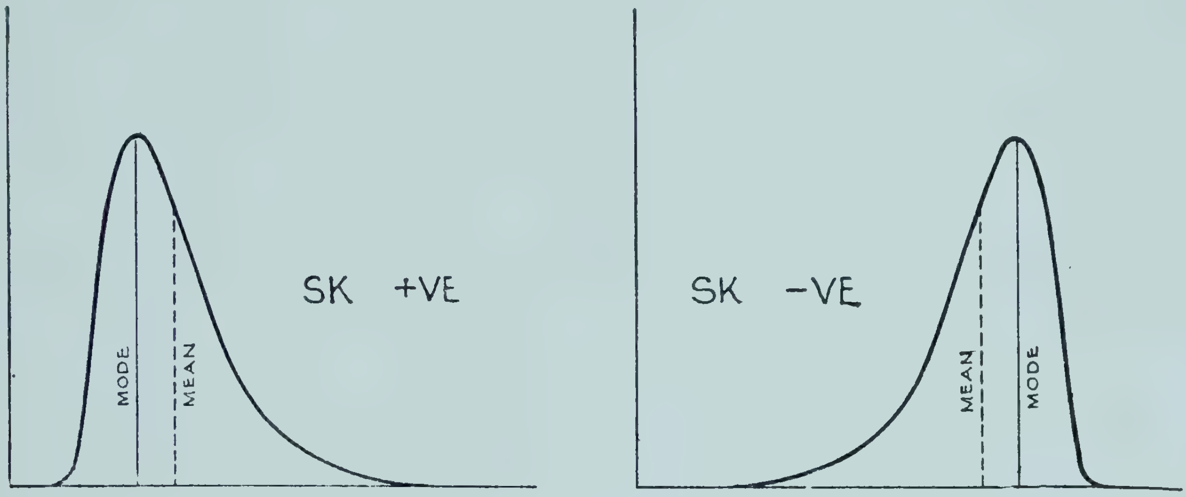

Fig. 36.—Skewness.
Positive and Negative.

Frequency Polygon

A frequency polygon is the graph obtained by assuming that the total frequency in any given class is concentrated at the centre of the class, and erecting ordinates of height proportional to the frequencies so concentrated. Fig. 37 is the frequency polygon plotted from Table 15.[1]

The frequency polygon is in general less accurate than the histogram because it does not represent a true frequency. It is however of value in presenting a series of overlapping frequency distributions.

Integral Frequency Curve

In the integral or cumulative frequency curve the frequency is successively accumulated class by class from the lower limit upwards. Table 17 is a table of cumulative frequencies for the distribution of solids-not-fat percentages in milk, and Fig. 38 is the integral frequency curve plotted from it. If it is desired to know the number of samples with a solids-not-fat percentage less than 8·5, the value of the ordinate having 8·5 as abscissa gives the approximate figure. If it is desired to know the number of samples with a solids-not-fat percentage exceeding 8·5 but less than 10, the difference between the ordinates having 8·5 and 10 as abscissae gives the approximate figure.

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[1] Page 180.

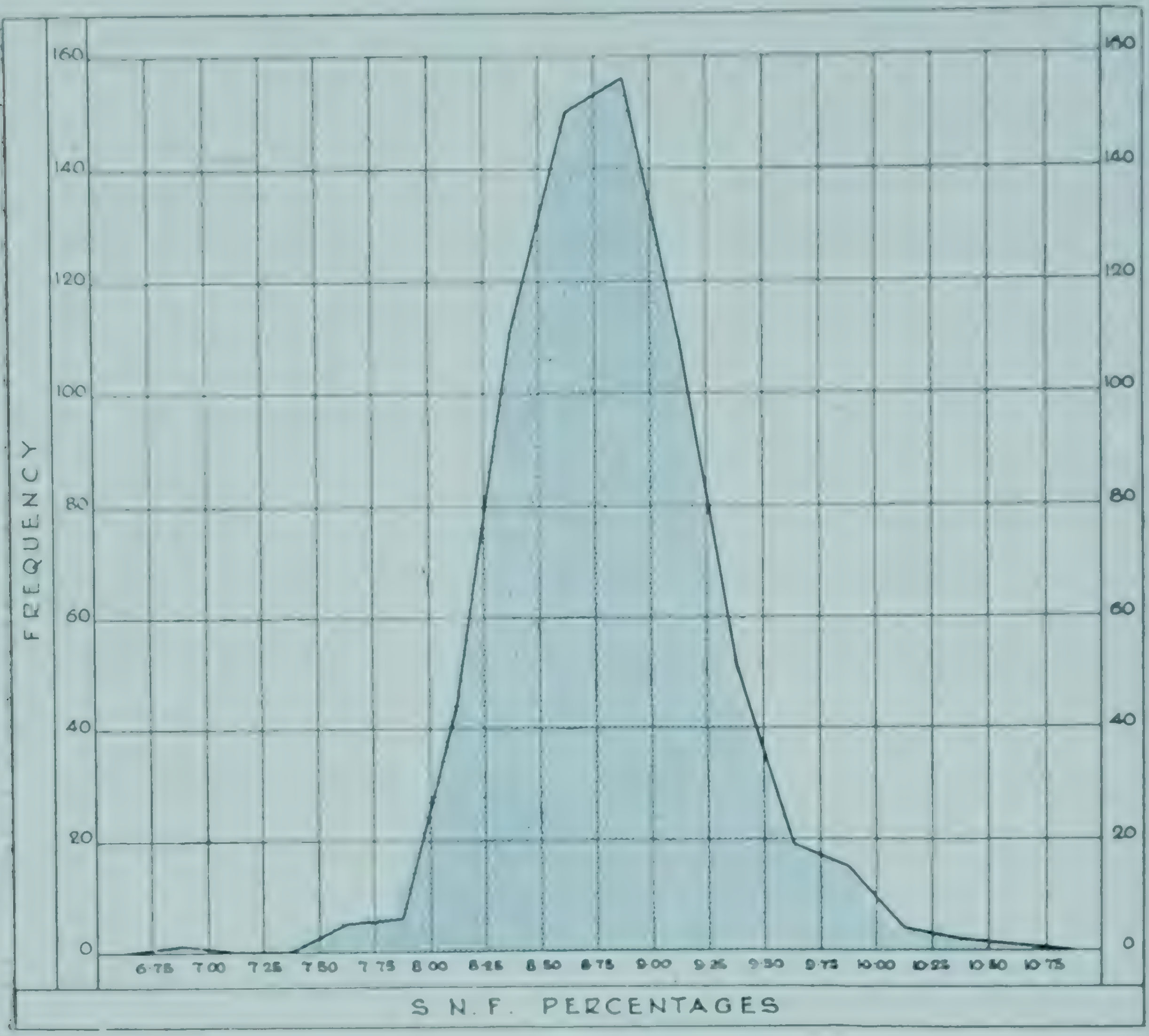

Fig. 37.—Frequency Polygon.
Solids-not-Fat Percentages in Milk, Table 15.[1]

TABLE 17.
CUMULATIVE FREQUENCY
Solids-not-Fat Percentages in Milk

Solids-not-Fat Percentages.	Frequency.	Cumulative Frequency.
-7·50	1	1
7·50-	5	6
7·75-	6	12
8·00-	44	56
8·25-	111	167
8·50-	150	317
8·75-	156	473
9·00-	110	583
9·25-	52	635
9·50-	19	654
9·75-	15	669
10·00-	4	673
10·25-	2	675
10·50-10·75	1	676
	676	

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[1] Page 180.

Ogive

If the cumulated frequencies are expressed as percentages of the total frequency, and set out on the horizontal scale with values of the variable on the vertical scale, the integral frequency curve takes the form called the ogive, in which the abscissa (x) and the ordinate (y) of any point are connected by the relation that y is the value of the variable, which had x per cent. of the observations below it. The ogive was devised by Galton. Apart from the fact that frequencies are plotted on the abscissa in the ogive, and on the ordinate in the integral frequency curve, the method of plotting the values in the two cases is fundamentally the same.

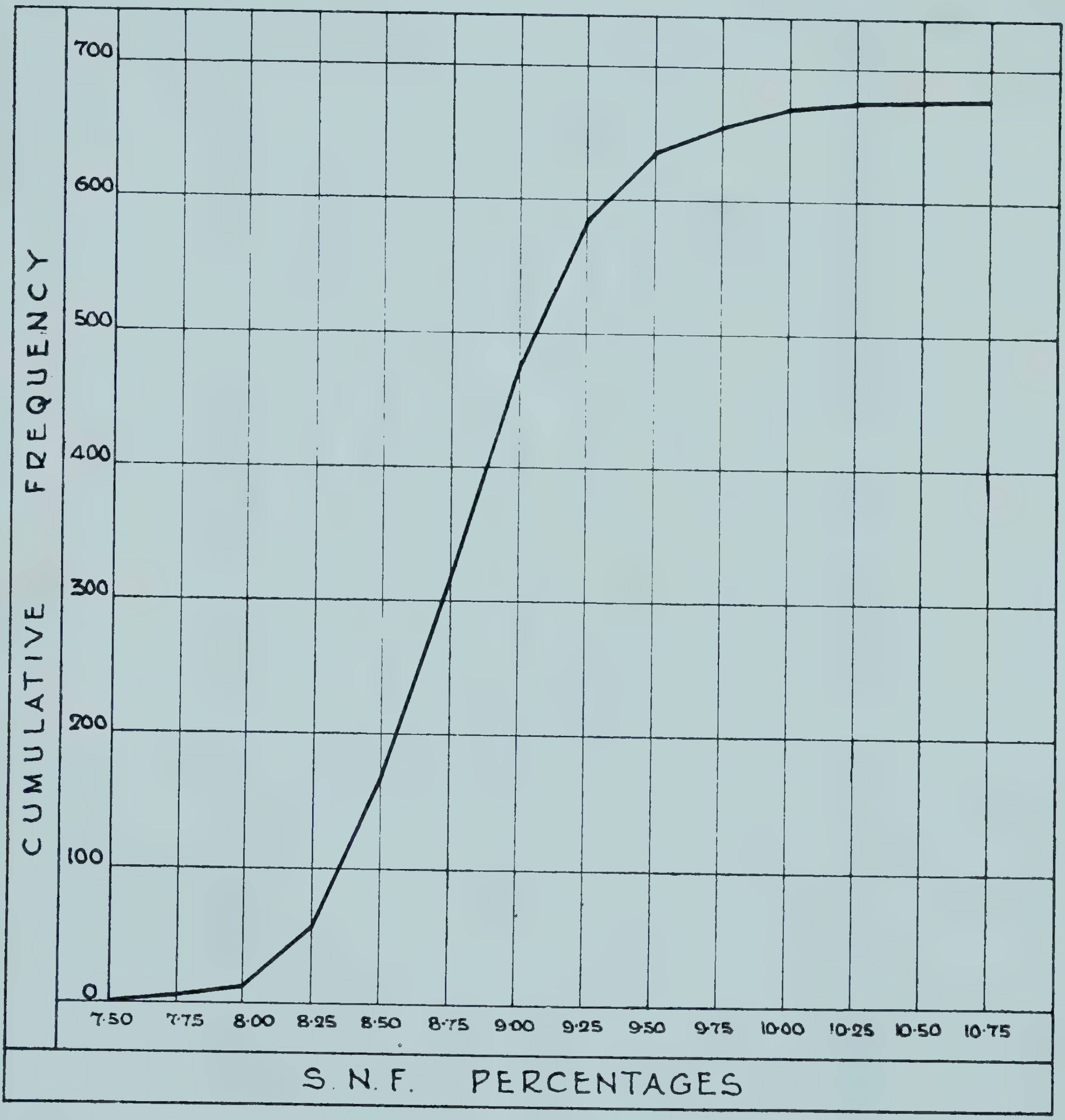


Fig. 38.—Integral Frequency Curve.
Solids-not-Fat Percentages in Milk, Table 17.

Normal Frequency Curve

The apparatus known as Galton's Quincunx shown in Fig. 39 consists of a smooth board into which a number of pins are driven in such a manner that every pin forms equilateral triangles with its nearest

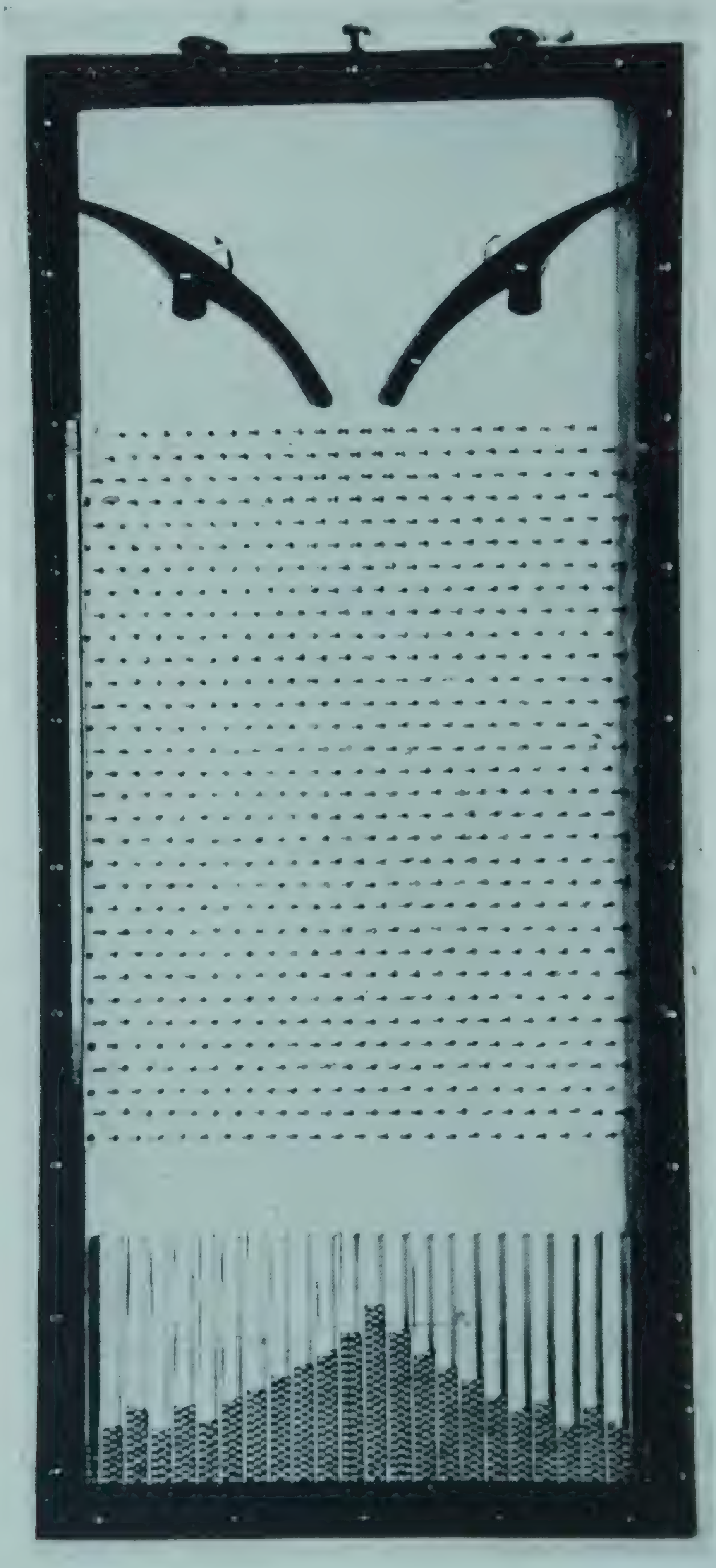


Fig. 39.—Galton's Quincunx.

neighbours. The arrangement is that of five spots on a die, sometimes used for plantations of trees. At the edges of the board are wooden rims and the whole is covered in with glass. At the head of the board under the glass is a funnel-shaped compartment containing smooth round shot. When the board is tilted so as to raise the head the shot in their descent strike the pins in the successive rows, each individual shot being deviated to the right or to the left at every encounter, until at last all come to rest in a row of rectangular bays at the foot of the board. The distribution of the shot in the various bays may be predicted fairly accurately: the middle bay will contain most, the bays next to the middle somewhat fewer, those farther from the middle fewer still, and the end bays fewest. The outline of the columns of shot in the row of bays traces out a more or less symmetrical shape which approximates to the normal frequency curve. The more shot and the smaller the shot, the more pins and the smaller the bays, the closer is the approximation.

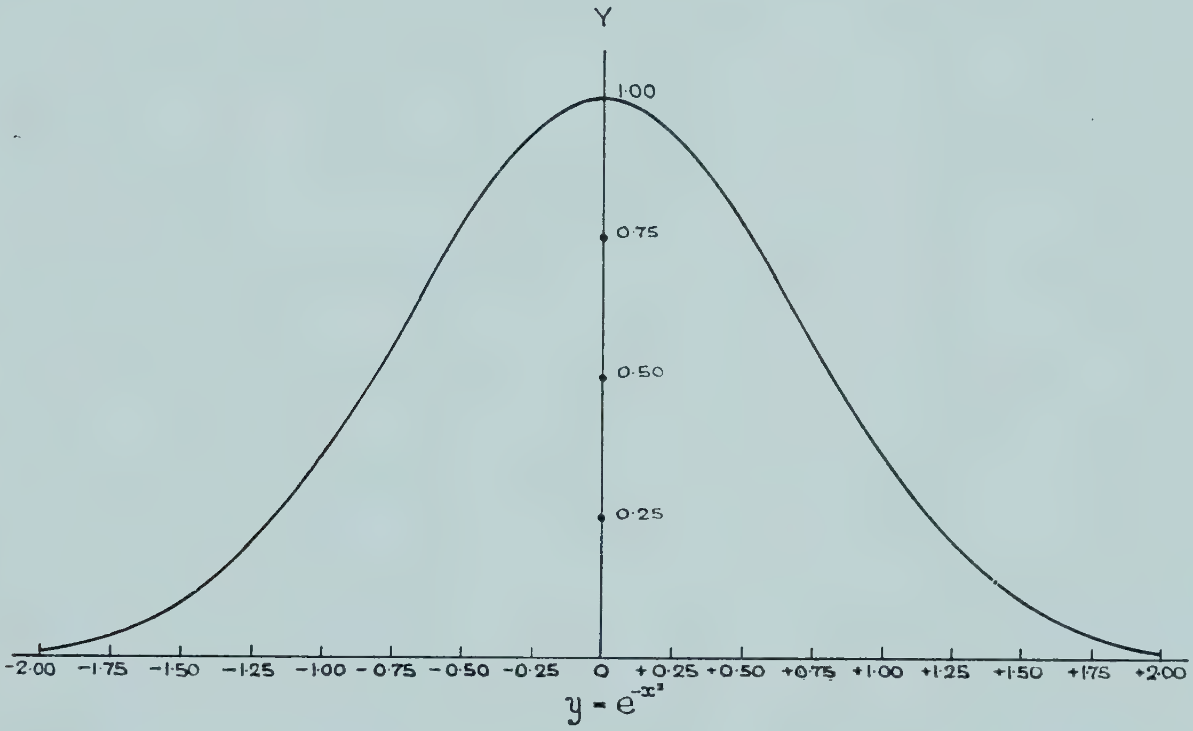


Fig. 40.—Symmetrical Curve.

Each shot in its career is subjected to a number of small and independent accidents. In rare cases a long run of luck continues to favour the course of a particular shot towards either outside place, but in the large majority of instances the accidents that cause deviation to the right balance in a greater or less degree those that cause deviation to the left. Thus most of the shot find their way into the bays that are situated near to a perpendicular line drawn from the outlet of the funnel, and the frequency with which individual shot stray to different distances to right or left of that line diminishes as the distances increase.

In the natural world or in human affairs those phenomena whose occurrence depends on the operation of the numerous uncontrollable causes collectively described as chance are capable of being represented by some kind of frequency curve. If the chance of the event happening is equal to that of its not happening the resulting curve is the normal frequency curve which has a symmetrical shape.

The normal frequency curve, known also as the normal probability curve or the normal curve of error, belongs to a type which may be represented by the equation

$$y = e^{-x^2}$$

where e is the base of Napierian logarithms, having the value 2·7182818. . . .

To draw the curve this equation may be written

$$-x^2 = \log_e y.$$

Since $\log_e 1 = 0$ and the logarithm of any number greater than 1 is positive and therefore cannot be equal to $-x^2$, it follows that y cannot be greater than 1. Assigning to y the values 0, 0·1, 0·2, . . . 0·9, 1, the values of $\log_e y$ can be found, and by means of a square root table x can be determined.

y.	$\text{Log}_e y$.	x.
0	$-\infty$	$\pm\infty$
0·1	—2·3026	± 1·52
0·2	—1·6095	± 1·27
0·3	—1·2040	± 1·10
0·4	—0·9163	± 0·96
0·5	—0·6932	± 0·83
0·6	—0·5108	± 0·71
0·7	—0·3567	± 0·60
0·8	—0·2232	± 0·47
0·9	—0·1054	± 0·32
1·0	0	0

From the above table the curve

$$y = e^{-x^2}$$

can be plotted as shown in Fig. 40. The curve is symmetrical about OY because for any possible value of y there are two values of x equal and opposite.

The equation to the normal frequency curve itself may be written in several ways of which

$$y = y_o e^{-\frac{x^2}{2\sigma^2}}$$

is one. In this equation y_o, the maximum ordinate, is a constant, e as before is the Napierian base, and σ represents the standard deviation. It will be apparent that the normal frequency curve defined by this equation is of the same general form as the curve represented by

$$y = e^{-x^2}$$

for the two only differ in their constants. The normal curve, like the other, is symmetrical about the Y axis since for any value of y there are two values of x equal and opposite. It tails off from OY to right and left since, as x tends to $\pm\infty$, Y tends to zero. Being symmetrical it has mean, median and mode coincident.

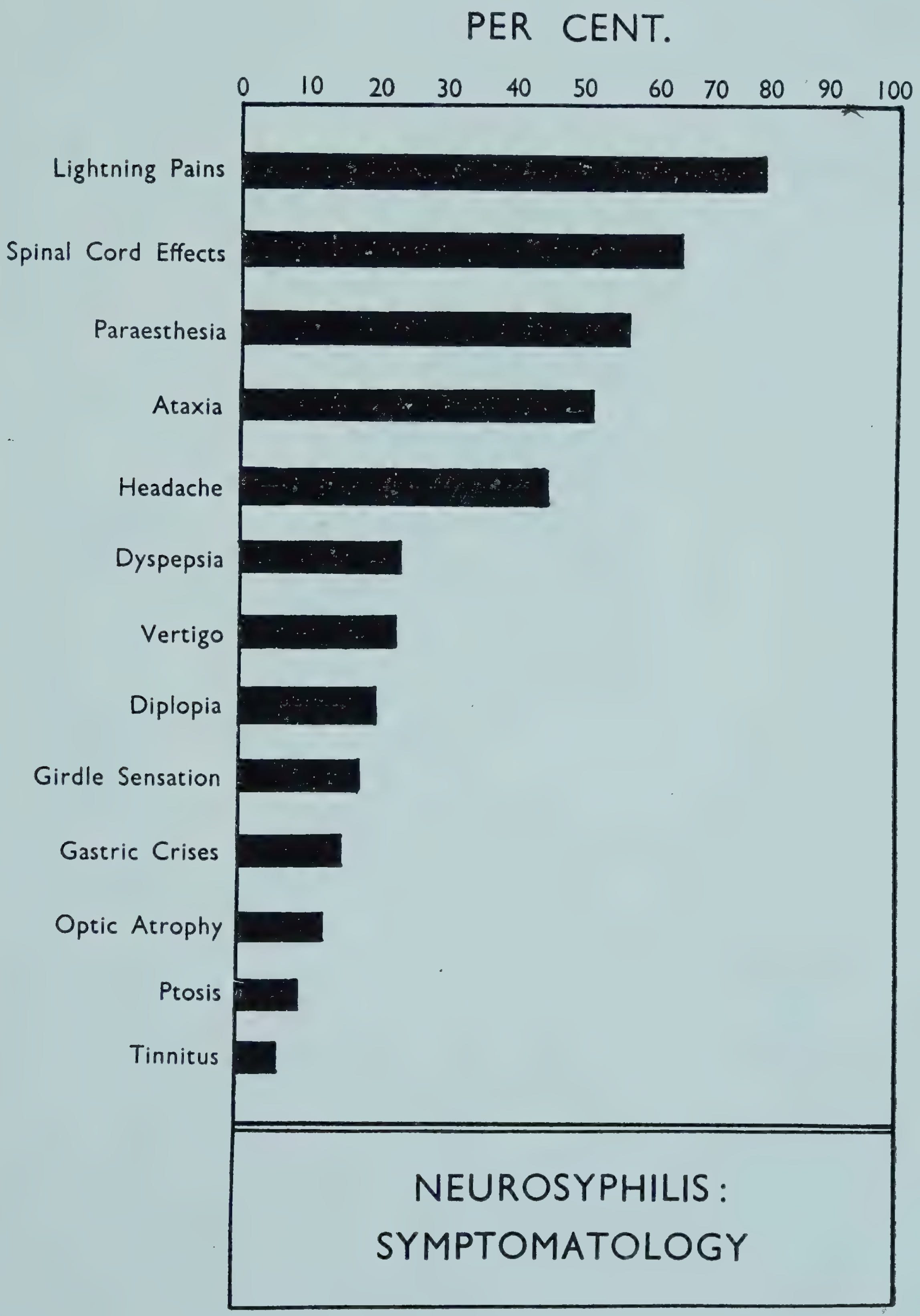


Fig. 41.—Bar Diagram.

Probable Error

If an observation be chosen at random from a group forming a normal distribution, there is an even chance of its value being within $0 \cdot 6745\,\sigma$ of the mean. For this reason $0 \cdot 6745\,\sigma$ is called the Probable

Error of such an observation. In essence it is, like the standard deviation, a measure of dispersion. It is written

$$\text{P.E.} = 0{\cdot}6745\ \sigma$$

II. DISCONTINUOUS VARIABLES

For the graphical presentation of *discontinuous* variables the bar (Fig. 41) and the sector diagrams (Fig. 42) may be employed. Where the significant feature to be portrayed is the magnitude of each variable with reference to the others, for example the relative frequency of the different symptoms of a disease, this relation may be shown in the bar diagram by appropriate lengths of lines. Where it is desired to bring out the proportion which each variable bears to the whole, a circle is drawn exhibiting sectors of the requisite number of degrees. Statistical maps in the form of spot maps (Fig. 43) may record the course of an epidemic, while shaded or coloured maps may depict its geographical incidence.

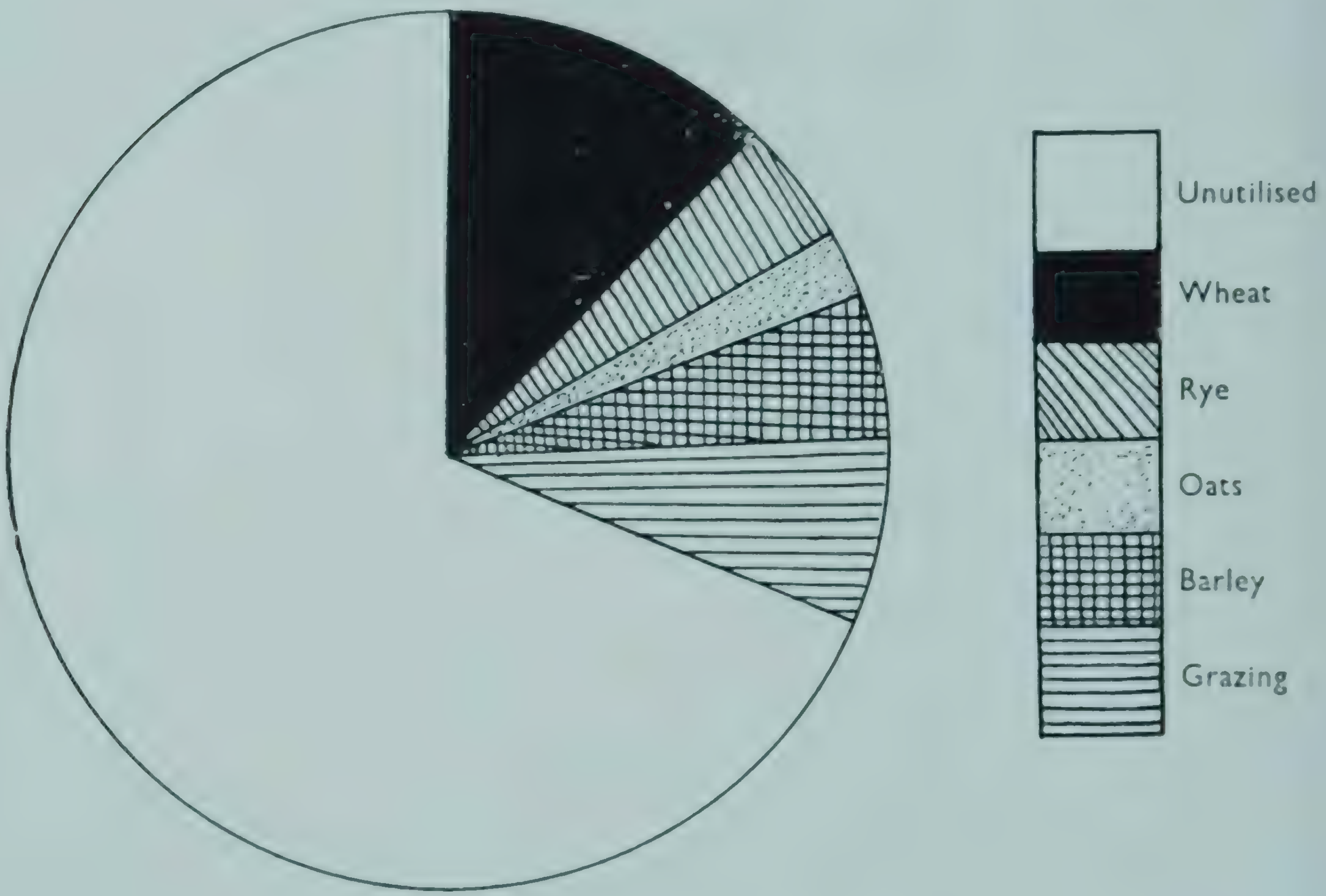


Fig. 42.—Sector Diagram.

Bar and sector diagrams are of considerable value when presenting statistics to the lay public during 'health week' exhibitions, immunisation campaigns and the like.

Statistical presentation has recently found a new medium in the ingenious and telling, if futuristic, charts of the Isotype Institute (Fig. 44).

The guiding principle in the submission of statistical data to lay groups is that the diagrams should be completely self-explanatory, simple in construction and tinted, when colour is likely to aid appreciation of their meaning.

Time Trend Diagram

A simple method of representing the trend of events with the lapse of time is to plot a curve with time as abscissa and value of the variable as ordinate.

During six decennial periods from 1861-70 to 1911-20 the death rates in Scotland per 100,000 of population declined progressively in the case of pulmonary tuberculosis from 268 to 105 and in the case of enteric fever from 42 to 4. Fig. 45 delineates these relationships in the form of two time trend curves, the upper for pulmonary tuberculosis and the lower for enteric fever. The upper curve, in comparison with the lower, cutting longer ordinates and falling more steeply, deals with larger numbers and represents a greater saving of lives. It would be proper to conclude that the time trend of pulmonary tuberculosis over the 60 years was of substantially greater benefit to the community than that of enteric fever. It would however be an error to draw the further conclusion that of the two diseases pulmonary tuberculosis was declining at a more rapid rate. In this particular instance a glance at Table 18 makes it clear that such was not the case, yet the steeper descent of the upper curve suggests it to the casual eye. The ordinary arithmetically

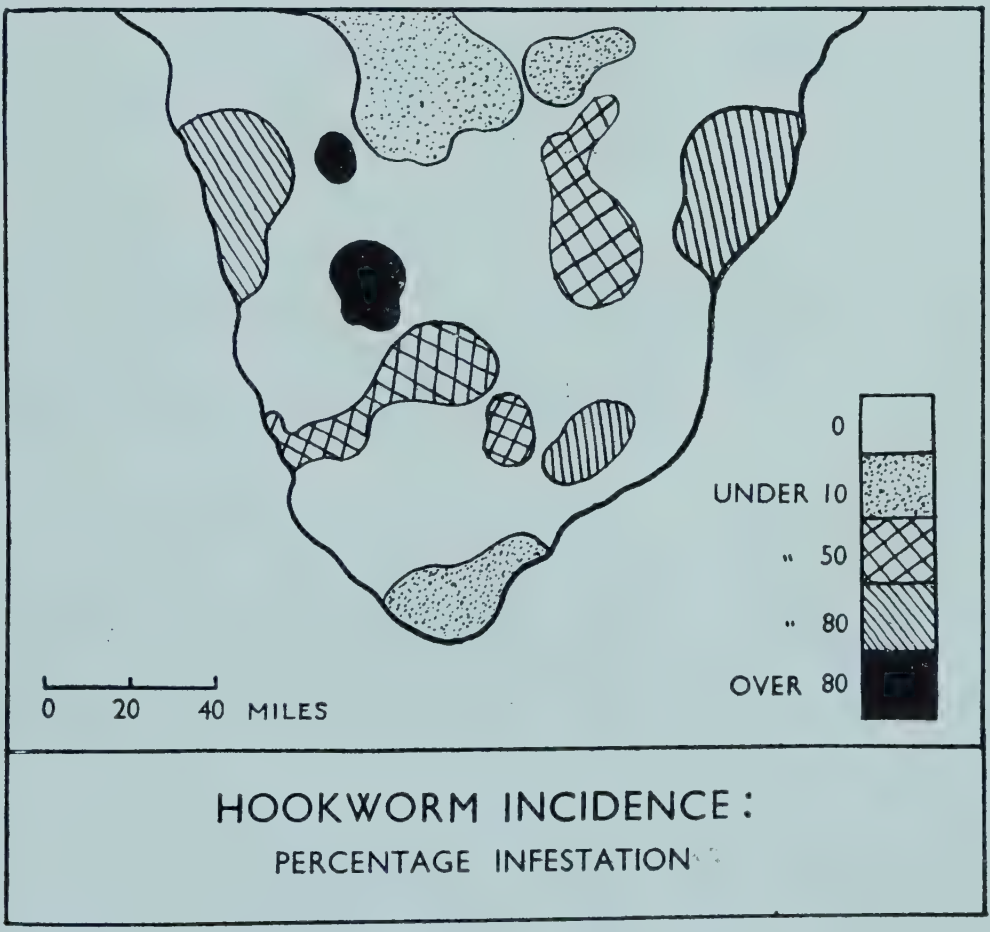
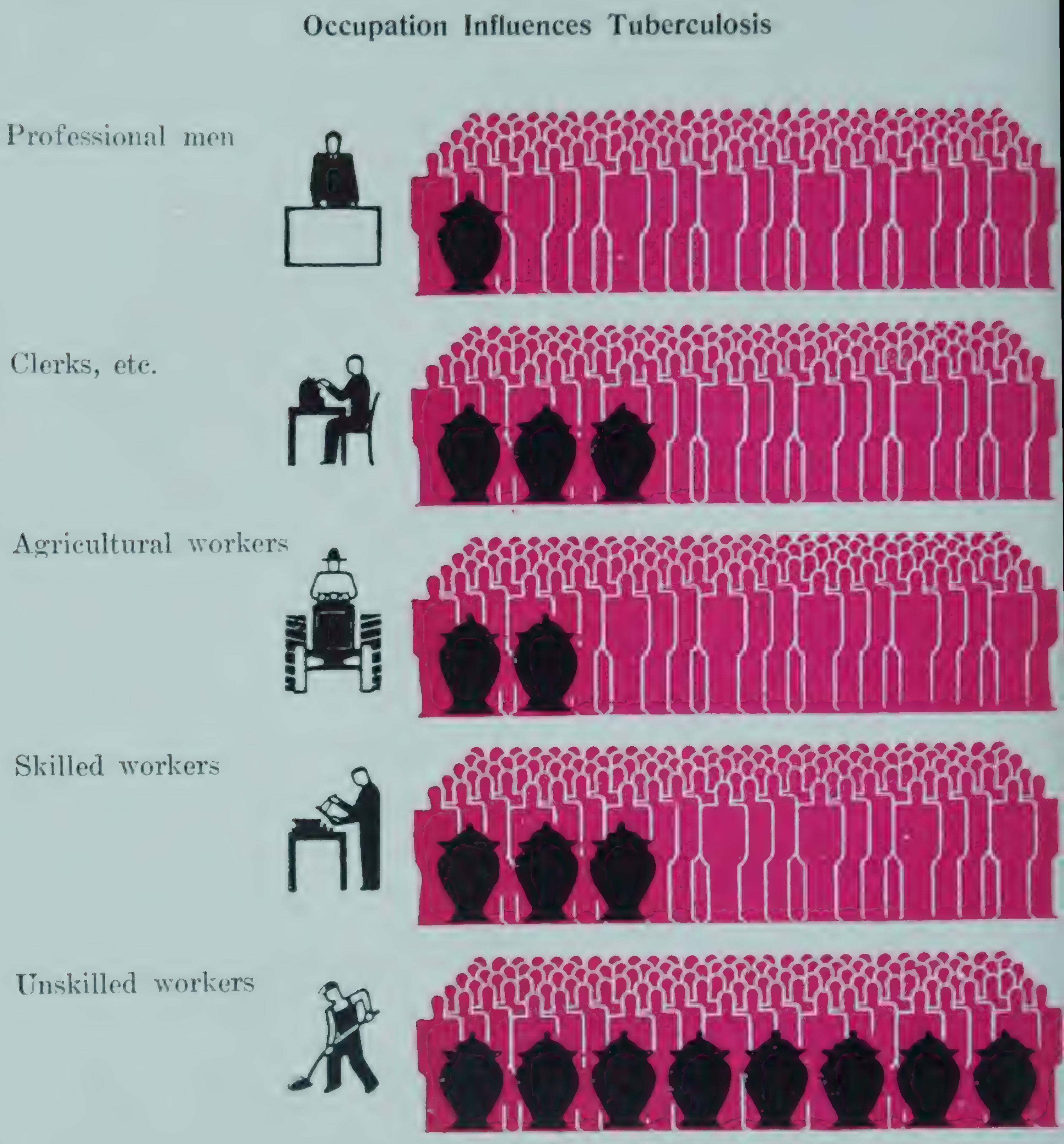


Fig. 43.—Spot Map.



Each urn: 25 deaths from tuberculosis per 100,000 workers in the age of 25 to 44 years.

ISOTYPE

Fig. 44.—Tuberculosis Incidence.
Graphic presentation on the Isotype System.

ruled paper, on which the two graphs are drawn, brings out magnitudes but not ratios. For the delineation of ratio curves arithlog ruling is employed.

Arithlog Ruling

In this type of ruling, while the abscissal scale is divided in the usual arithmetical manner, the ordinate scale is graduated in proportion to the logarithms of the numbers up to 10 repeated in successive bands.

When a quantity falls in two steps from 1000 to 100 and from 100 to 10, the difference in units for the first step is 900 and for the second

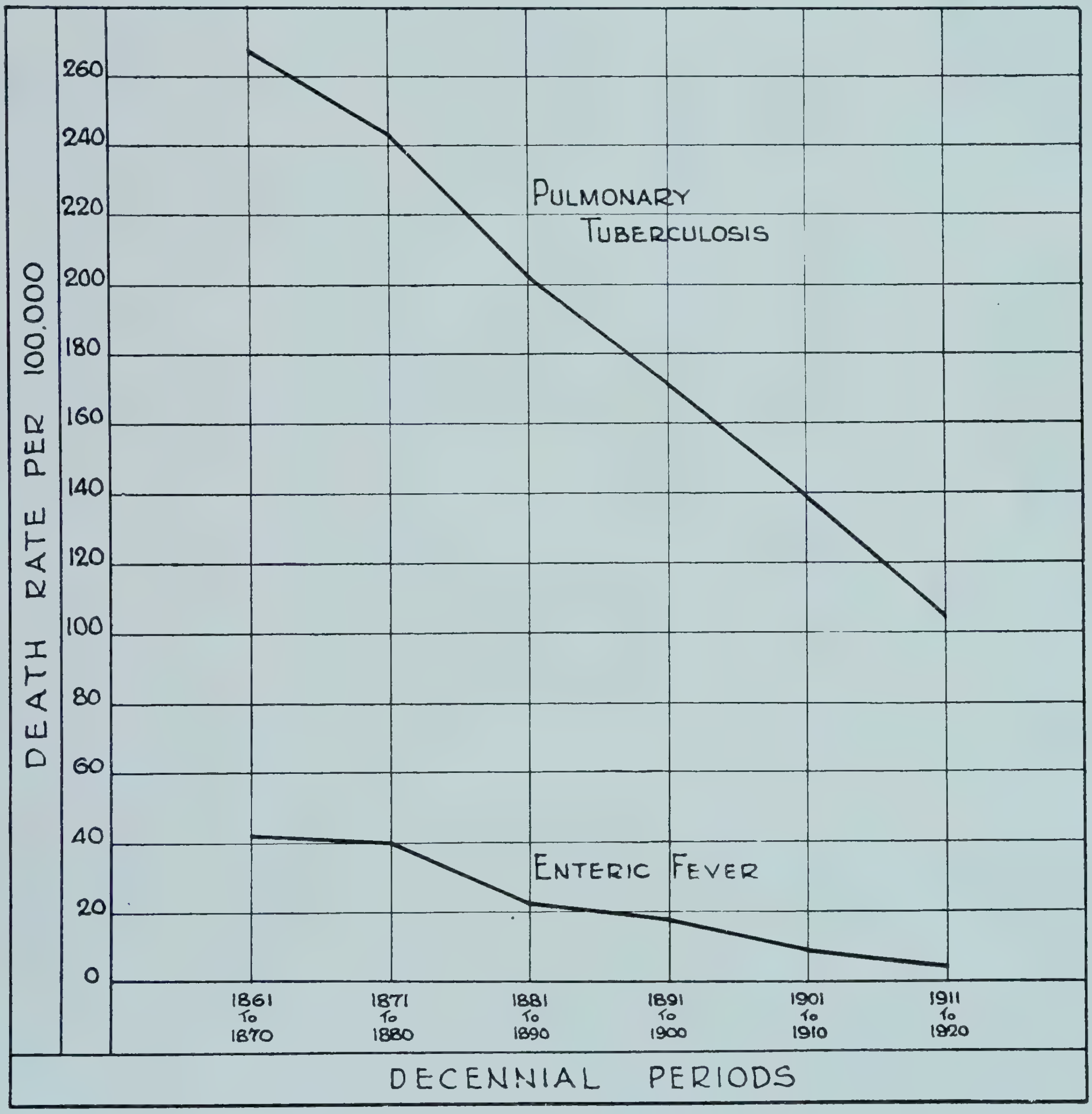


Fig. 45.—Time Trend. Arithmetical Ruling.
Scotland: Death Rates per 100,000: 1861-1920, Table 18.

TABLE 18.
DEATH RATES PER 100,000
SCOTLAND

Period.	Pulmonary Tuberculosis	Enteric Fever.
1861-1870	268	42
1871-1880	244	40
1881-1890	202	23
1891-1900	171	18
1901-1910	139	9
1911-1920	105	4

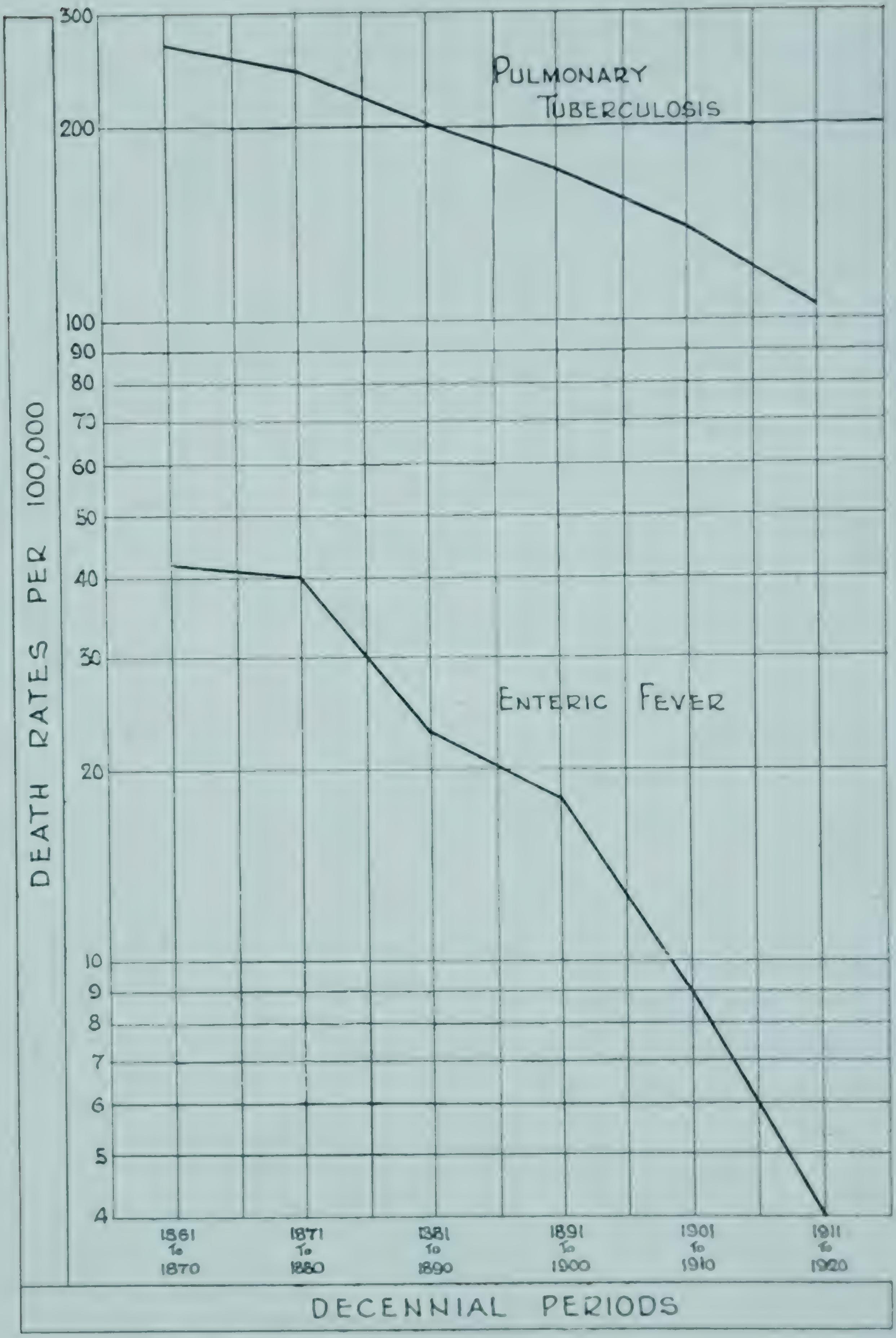


Fig. 46.—Time Trend. Arithlog Ruling.
Scotland: Death Rates per 100,000: 1861-1920, Table 18.

90. Plotted on ordinary arithmetical ruling the distance between the 1000 and the 100 levels would be 10 times that between the 100 and the 10 levels. But the proportional reduction is the same in both cases, namely 90 per cent. And the difference between the logarithms of the numbers is the same in both cases, namely 1. Plotted therefore on the arithlog ruling of Fig. 46, in which the ordinate scale is logarithmic, the distance between the 1000 and the 100 levels is the same as the distance between the 100 and the 10 levels. The arithlog graph drawn through the points concerned is a ratio graph and stands for percentages.

It is a property of arithlog ruling that a graph representing a magnitude changing at a uniform rate per cent. forms a straight line. If the graph bends the percentage rate of change is altering. Two parallel curves on the same arithlog chart indicate equal percentage rates of change. If one of the curves is steeper than the other, the steeper curve signifies a more rapid percentage rate. The inclination of the straight line joining any two points on a ratio curve shows the average percentage rate of change between them.

When the data of Table 18 are plotted not on arithmetical ruling as in Fig. 45 but on arithlog ruling as in Fig. 46, it is at once apparent to the eye that enteric fever and not pulmonary tuberculosis was decreasing during the period at the faster rate.

Smoothing

Smoothing as applied to a time trend series consists in replacing the original figures by others designed to moderate the effect of incidental fluctuations and so enable a smooth graph to be drawn in which the general trend of the series may be more obvious. Among ways of smoothing are (1) the method of moving averages and (2) the method of least squares.

Method of Moving Averages. Table 19 exhibits the application of this method to the Scottish death rates from 1901-1921. The original death rate of column 2, which relates to a single year, is replaced by the average of the annual death rates for the nine years centring on the year in question. Each successive sum, shown in column 4, is obtained by dropping the first death rate of its predecessor and adding another on. When the resulting averages, entered in column 6, are plotted as shown in Fig. 47, the smoothing effect of the method is brought out.

Method of Least Squares. The method of least squares is applied in Table 20 to the Scottish Infant Mortality rates from 1900 to 1921. x is the serial number of the year, y is the infant mortality rate per 10,000 live births.

TABLE 19.

METHOD OF MOVING AVERAGES.

Death Rates per 1000. Scotland, 1901-1921.

1. Year.	2. Rate.	3. 9 Years.	4. Totals.	5. Middle Years.	6. Average of 9 Years.
1897	18·4	...	...	...	...
8	18·0	...	...	...	...
9	18·1	...	...	...	...
1900	18·5	...	...	...	...
1	17·9	1897-1905	158·3	1901	17·6
2	17·3	1898-1906	156·3	2	17·4
3	16·8	1899-1907	154·9	3	17·2
4	17·1	1900-1908	153·4	4	17·0
5	16·2	1901-1909	150·7	5	16·7
6	16·4	1902-1910	148·1	6	16·5
7	16·6	1903-1911	145·9	7	16·2
8	16·6	1904-1912	144·4	8	16·0
9	15·8	1905-1913	142·8	9	15·9
1910	15·3	1906-1914	142·1	1910	15·8
1	15·1	1907-1915	142·8	1	15·9
2	15·3	1908-1916	140·9	2	15·7
3	15·5	1909-1917	138·7	3	15·4
4	15·5	1910-1918	139·2	4	15·5
5	17·1	1911-1919	139·5	5	15·5
6	14·7	1912-1920	138·4	6	15·4
7	14·4	1913-1921	136·7	7	15·2
8	16·3	1914-1922	136·1	8	15·1
9	15·6	1915-1923	133·5	9	14·8
1920	14·0	1916-1924	130·8	1920	14·5
1	13·6	1917-1925	129·5	1	14·4
2	14·9	...	...	...	...
3	12·9	...	...	...	...
4	14·4	...	...	...	...
5	13·4	...	...	...	...

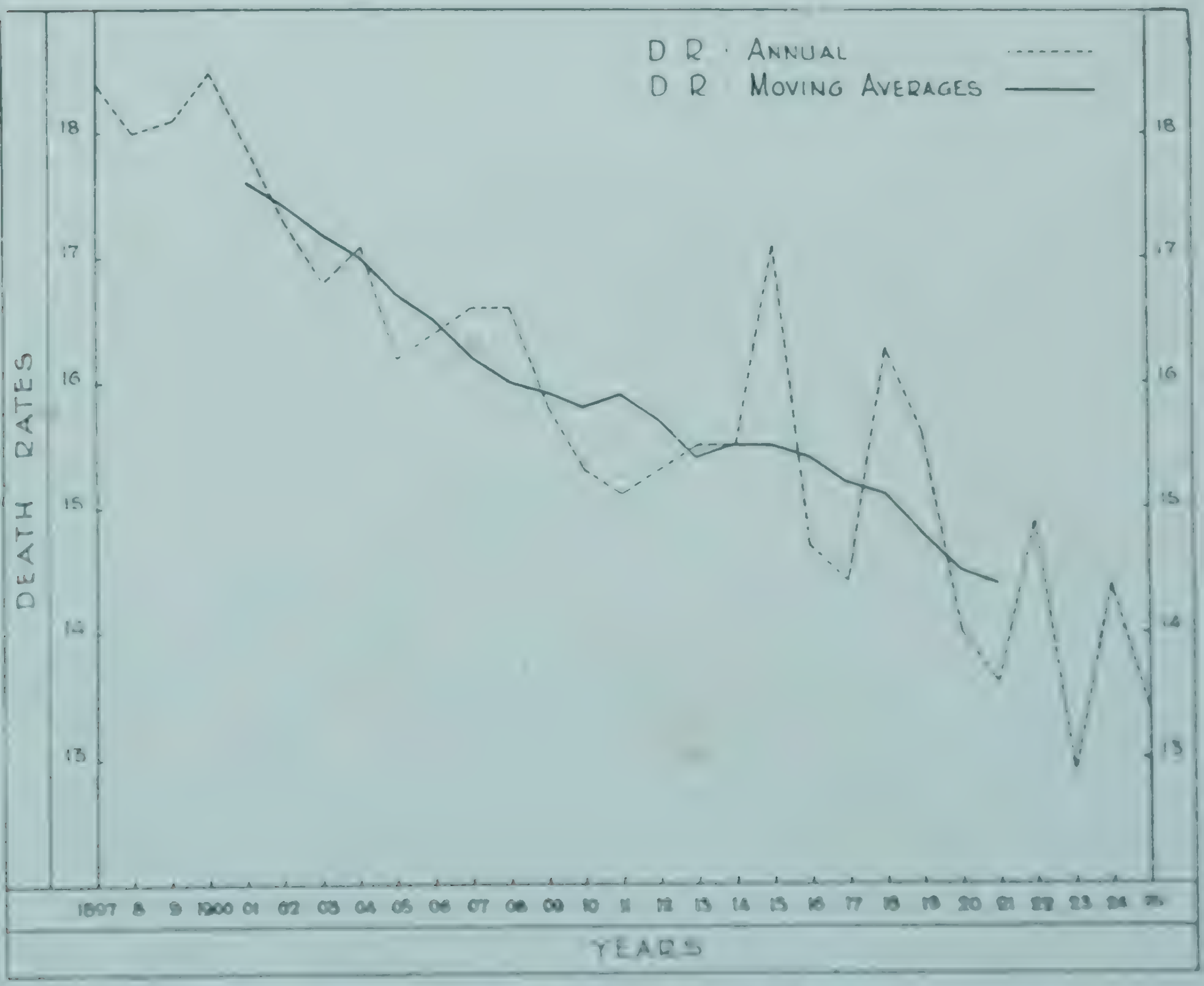


Fig. 47.—Smoothing by Method of Moving Averages. Scotland: Death Rates per 1,000: 1901-1921, Table 19.

TABLE 20.

METHOD OF LEAST SQUARES

Infant Mortality Rates. Scotland, 1900-1921.

Year.	x.	y.	x^2.	xy.	Trend Values.
1900	1	1,285	1	1,285	1,249
1901	2	1,294	4	2,588	1,236
1902	3	1,134	9	3,402	1,223
1903	4	1,175	16	4,700	1,210
1904	5	1,231	25	6,155	1,196
1905	6	1,162	36	6,972	1,183
1906	7	1,150	49	8,050	1,170
1907	8	1,097	64	8,776	1,157
1908	9	1,210	81	10,890	1,143
1909	10	1,077	100	10,770	1,130
1910	11	1,083	121	11,913	1,117
1911	12	1,125	144	13,500	1,104
1912	13	1,055	169	13,715	1,091
1913	14	1,096	196	15,344	1,077
1914	15	1,106	225	16,590	1,064
1915	16	1,265	256	20,240	1,051
1916	17	971	289	16,507	1,038
1917	18	1,075	324	19,350	1,024
1918	19	998	361	18,962	1,011
1919	20	1,016	400	20,320	998
1920	21	920	441	19,320	985
1921	22	903	484	19,866	972
22	253	24,428	3,795	269,215	
n	Σx	Σy.	Σx^2	Σxy	

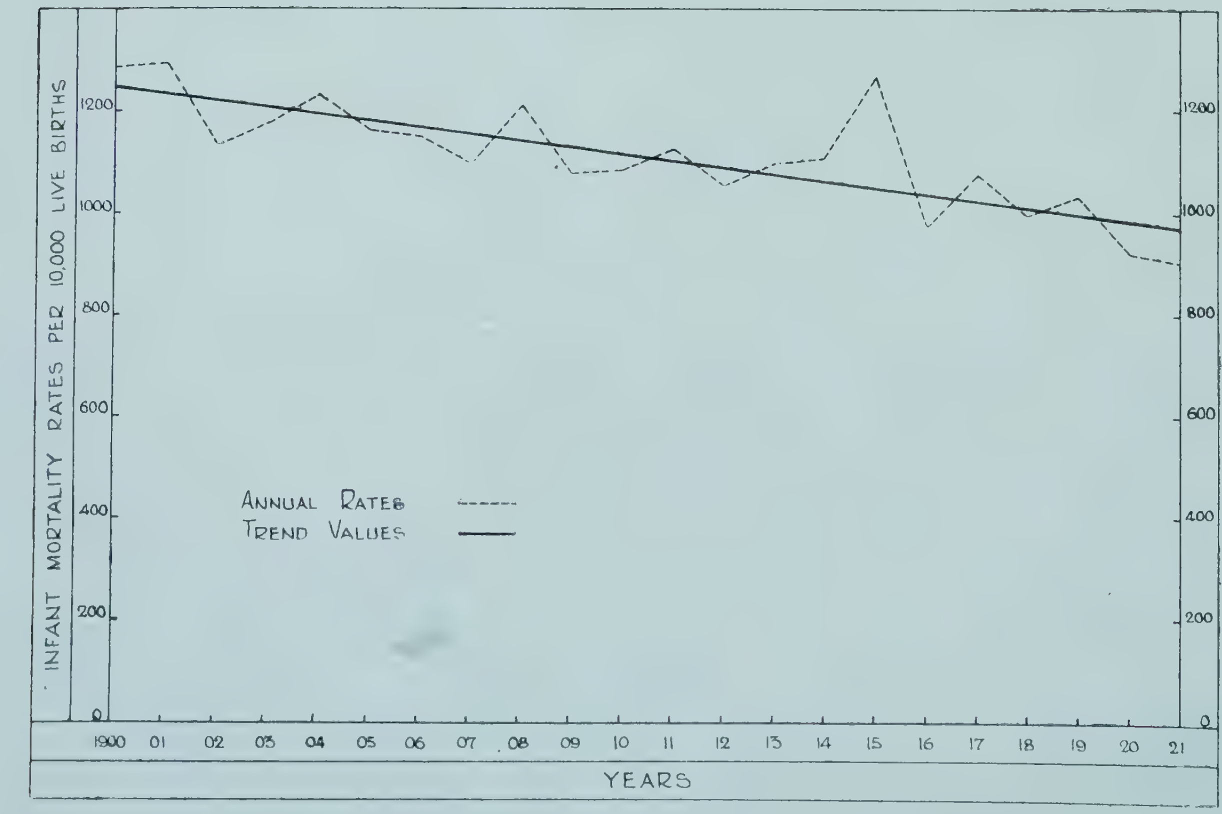


Fig. 48.—Smoothing by Method of Least Squares. Scotland: Infant Mortality Rates: 1900-1921, Table 20.

By the theory of least squares, the best equation of first degree connecting observed magnitude y and x is

$$y = mx + b,$$

where

$$m = \frac{\Sigma x \cdot \Sigma y - n\Sigma(xy)}{[\Sigma x]^2 - n\Sigma x^2}$$

and

$$b = \frac{\Sigma x \cdot \Sigma(xy) - \Sigma x^2 \cdot \Sigma y}{[\Sigma x]^2 - n\Sigma x^2}$$

Substituting the values, we have

$$m = \frac{253 \times 24428 - 22 \times 269215}{(253)^2 - 22 \times 3795}$$
$$= \underline{\underline{-13 \cdot 22}}$$

and

$$b = \frac{253 \times 269215 - 3795 \times 24428}{(253)^2 - 22 \times 3795}$$
$$= \underline{\underline{1262 \cdot 4.}}$$

The equation of the straight line which most closely fits the graph is

$$y = -13 \cdot 22x + 1262 \cdot 4.$$

By substituting the values of x we obtain the *Trend Values* in the last column of the table. The trend values together with the original annual rates are plotted in Fig. 48.

CORRELATION

The degree of correlation between two variables may be measured by means of the correlation coefficient r. If x and y are the deviations of the variables from their respective mean values and σ_x and σ_y are their standard deviations, the number of pairs of observations being N, the correlation coefficient is expressed by the formula

$$r = \frac{\Sigma xy}{N\sigma_x\sigma_y} = \frac{p}{\sigma_x\sigma_y}$$

where $p = \frac{\Sigma xy}{N}$, known as the Mean Product.

Data for the calculation of the coefficient of correlation between two variables are presented in Table 21. The two variables are Cancer Death Rate (X) and Infant Mortality Rate (Y) for the 4-year period 1910-1913 in municipal wards of Glasgow.[1] In column 2 are the standardised death rates from cancer and in column 5 the mean infant mortality rates. The arithmetical means of columns 2 and 5 are calculated in the usual manner and the deviations x and y from the means are written down in columns 3 and 6, each with its proper algebraic sign. The deviations are then squared (columns 4 and 7), and the standard deviations calculated. The products of column 3 by

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[1] In the original investigation, which related to the influence of social status on cancer, the incidence of infant mortality was chosen as a criterion of social status.

Table 21.

Two-Fold Correlation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Municipal Wards	Standardised Cancer Death Rate per 1000 from Age 25 upwards, 1910-13.	Deviation of Number in Column (2) from Mean 1·888.	Square of Number in Column (3).	Mean Infant Mortality Rate, 1910-13.	Deviation of Number in Column (5) from Mean 121.	Square of Number in Column (6).	Product of Numbers in Columns (3) and (6).
	X	x	x^2	Y	y	y^2	xy
Dalmarnock	1·672	—0·216	0·046656	139	+18	324	—3·888
Calton	1·993	+0·105	0·011025	156	+35	1,225	+ 3·675
Mile-end	2·297	+0·409	0·167281	146	+25	625	+10·225
Whitevale	1·747	—0·141	0·019881	147	+26	676	—3·666
Dennistoun	1·814	—0·074	0·005476	81	—40	1,600	+ 2·960
Springburn	1·724	—0·164	0·026896	118	— 3	9	+ 0·492
Cowlairs	1·836	—0·052	0·002704	124	+ 3	9	—0·156
Townhead	1·798	—0·090	0·008100	140	+19	361	—1·710
Blackfriars	1·745	—0·143	0·020449	159	+38	1,444	—5·434
Broomielaw	2·299	+0·411	0·168921	160	+39	1,521	+16·029
Anderston	1·983	+0·095	0·009025	125	+ 4	16	+ 0·380
Sandyford	1·931	+0·043	0·001849	142	+21	441	+ 0·903
Park	1·686	—0·202	0·040804	82	—39	1,521	+ 7·878
Cowcaddens	2·000	+0·112	0·012544	155	+34	1,156	+ 3.808
Woodside	1·686	—0·202	0·040804	118	— 3	9	+ 0·606
Hutchesontown	2·274	+0·386	0·148996	129	+ 8	64	+ 3·088
Gorbals	1·872	—0·016	0·000256	137	+16	256	—0·256
Kingston	1·956	+0·068	0·004624	136	+15	225	+ 1·020
Govanhill	1·681	—0·207	0·042849	97	—24	576	+ 4·968
Langside	1·772	—0·116	0·013456	61	—60	3,600	+ 6·960
Pollokshields	1·662	—0·226	0·051076	61	—60	3,600	+13,560
Kelvinside	1.728	—0·160	0·025600	40	—81	6,561	+12,960
Maryhill	2·088	+0·200	0·040000	99	—22	484	—4·400
Kinning Park	2·063	+0·175	0·030625	144	+23	529	+ 4·025
24	45·307		0·939897 ...	... 2,896		26,832 ...	93·537 —19·510 =74·027
N	Mean 1·888		Σx^2	Mean 121		Σy^2	$\frac{\Sigma xy}{N}$ =3·084

column 6 are entered in column 8. From the algebraic sum of the products in column 8 the mean product p is found

$$p = \frac{\Sigma xy}{N} = \frac{74\cdot027}{24} = 3\cdot084$$

$$\sigma_x = \sqrt{\frac{0\cdot939897}{24}} = 0\cdot19789$$

$$\sigma_y = \sqrt{\frac{26832}{24}} = 33\cdot4$$

$$\therefore r = \frac{p}{\sigma_x \sigma_y} = \frac{3\cdot084}{0\cdot19789 \times 33\cdot4} = 0\cdot467$$

$$\text{P.E. of } r = 0\cdot6745 \frac{1 - r^2}{\sqrt{N}} = \pm 0\cdot107$$

$$\therefore r = 0\cdot467 \pm 0\cdot107.$$

The value of r may range from -1 through zero to $+1$. A negative correlation means that the variables vary in opposite senses, a positive correlation that they vary in the same sense. If $r=1$ correlation is perfect; if $r=0$ correlation is absent.

Correlation may be taken as significant if r is not less than P.E. × 3. In that event the odds are 22 to 1 that the true value lies within the limits determined. If r is not less than P.E. × 4 the odds are overwhelming.

The following are examples of coefficients of correlation and their probable errors:

Grade of Correlation.	Example.	Coefficient of Correlation.
High . .	Specific gravity and percentage S.N.F. in milk samples from Ayrshire cows.	$+0{\cdot}8016 \pm 0{\cdot}012$
	Percentage S.N.F. and percentage casein nitrogen in milk samples from cows of all breeds.	$+0{\cdot}7475 \pm 0{\cdot}014$
Medium .	Stature and vital capacity in candidates for R.A.F.	$+0{\cdot}568 \pm 0{\cdot}013$
	Intelligence of school children and social position.	$+0{\cdot}3671 \pm 0{\cdot}043$
Low . .	Scarlet Fever: case mortality and isolation.	$-0{\cdot}261 \pm 0{\cdot}046$
	Scarlet Fever: Poverty and death rate.	$+0{\cdot}195 \pm 0{\cdot}067$

Regression

Sir F. Galton in a paper entitled 'Regression towards Mediocrity in Hereditary Stature' showed that the stature of sons of tall fathers was not equal to the stature of their fathers but was rather nearer the mean stature of the population as a whole. He described this as a 'regression' of the variable towards the general average.

If two variables x and y are related, the mean of the values of y observed in association with values of x from a specified short range, whose mid-value is, say, x', will vary according to the choice of x'. The term 'regression' is now used, even when the variables are different in kind and the word in Galton's sense is meaningless, to express the dependence of mean y on x or of mean x on y.

For example, it is desired to investigate the regression of butter fat percentages on solids-not-fat percentages in the 676 samples of milk already noted.[1] Table 22 is drawn up in double entry, setting out in rows or horizontal arrays the frequencies of solids-not-fat percentages and in columns or vertical arrays the frequencies of butter fat percentages. A number in a compartment of this Table is called a cell frequency. The cell frequency 25 in the column headed 8·75- and the row marked 4·00- indicates that 25 samples of the total 676 had a solids-not-fat percentage of 8·75-9·00 and a butter fat percentage of 4·00-4·25. The means of the arrays of butter fat percentages are calculated for each solids-not-fat class interval and written below the totals. Then in Figure 49, which is an example of the graphical presentation, solids-not-fat class mid-points being marked off on the X axis and means of the arrays of butter fat percentages on the Y axis, the values, as plotted, are seen to lie somewhat approximately on a straight line inclined in such a manner that as the solids-not-fat percentages increase the mean butter fat percentages increase also.

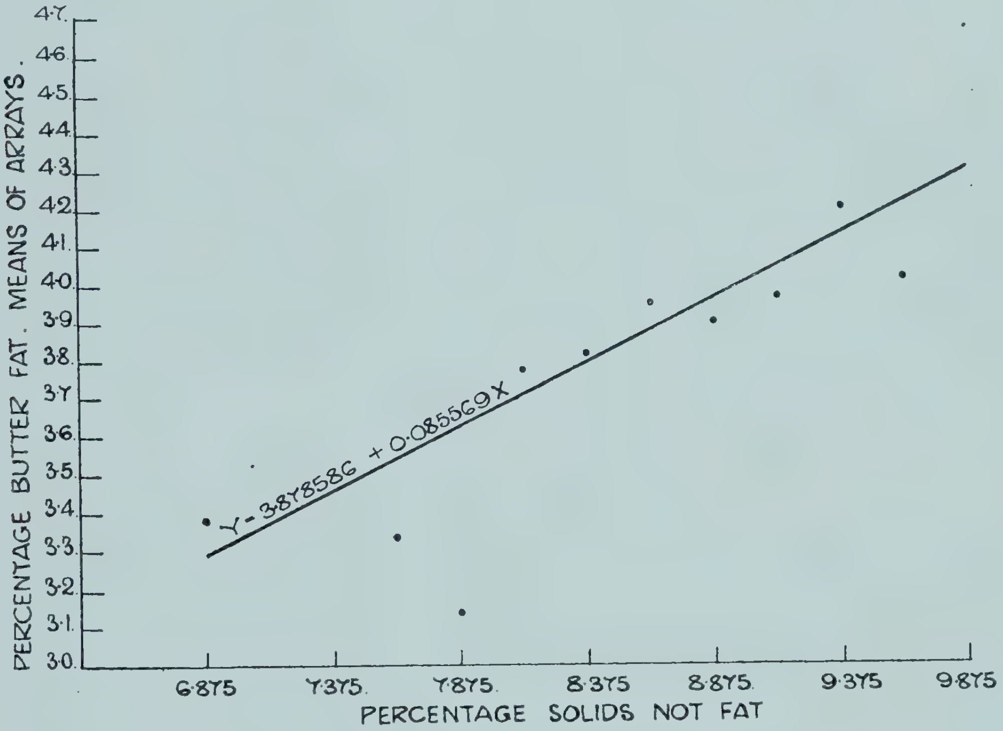

Fig. 49.—Regression of Butter Fat Percentage on Solids-not-Fat.

To find the best fitting straight line to the observed means of the y arrays of type x, that is, the Line of Regression of y on x, use is made of Table 23 in which columns 1, 2 and 3 are the same as columns 2, 3 and 4 of Table 16 with the last three class intervals omitted for convenience, while column 4 contains the means of butter fat arrays (y_x) from Table 22 with the same omission. Column 5 is column 3 (n_x, the number in array of type x) multiplied by column 4, and column 6 is column 5 multiplied by column 2.

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[1] Table 15, page 180.

TABLE 22.

ARRAYS OF FREQUENCIES: BUTTER FAT AND SOLIDS-NOT-FAT

Percentage Butter Fat.	Percentage Solids-not-Fat.																
	6·75-	7·00-	7·25-	7·50-	7·75-	8·00-	8·25-	8·50-	8·75-	9·00-	9·25-	9·50-	9·75-	10·00-	10·25-	10·50-10·75	Total.
2·25- . .	...	...	...	1	1	1	4	2	4	1	...	...	...	...	...	..	14
2·50- . .	...	...	...	...	1	2	2	1	1	2	...	...	...	...	...	...	9
2·75- . .	...	...	...	...	2	4	5	8	9	2	2	1	...	...	...	...	33
3·00- . .	...	...	...	1	...	3	9	8	6	10	2	...	1	...	...	...	40
3·25- . .	1	...	...	1	1	7	22	26	28	11	9	2	1	...	...	...	109
3·50- . .	...	...	...	1	...	5	14	21	14	16	3	3	1	...	...	...	78
3·75- . .	...	...	...	...	...	8	18	24	24	23	6	2	1	...	...	...	106
4·00- . .	...	...	...	1	...	5	17	14	25	16	11	3	2	...	...	...	94
4·25- . .	...	...	...	...	...	2	7	17	16	11	4	2	1	...	...	...	60
4·50- . .	...	...	...	...	1	1	5	8	12	4	1	5	2	1	...	...	40
4·75- . .	...	...	...	...	...	3	2	9	12	6	7	1	1	1	...	...	42
5·00- . .	...	...	...	...	...	2	...	4	2	2	2	...	2	1	...	...	15
5·25- . .	...	...	...	...	...	...	...	2	1	3	...	...	...	...	...	...	6
5·50- . .	...	...	...	...	...	...	...	3	1	1	2	...	...	...	...	...	7
5·75- . .	...	...	...	...	...	1	1	1	...	...	1	...	1	...	1	...	6
6·00- . .	...	...	...	...	...	...	1	...	1	...	1	...	...	...	...	...	3
6·25- . .	...	...	...	...	...	...	1	1	...	2	...	...	1	1	1	...	7
6·50- . .	...	...	...	...	...	...	1	...	...	...	...	...	1	...	...	...	2
6·75-7·00 .	...	...	...	...	...	...	2	1	...	...	1	...	...	...	...	1	5
Total	1	...	...	5	6	44	111	150	156	110	52	19	15	4	2	1	676
Means of arrays of butter fat percentages.	3·375	...	...	3·325	3·125	3·773	3·823	3·950	3·907	3·959	4·202	4·072	4·658	5·25	6·125	6·875	

TABLE 23.

REGRESSION OF BUTTER FAT PERCENTAGE ON SOLIDS-NOT-FAT
FITTING OF STRAIGHT LINE

1. S.N.F. Per Cent. Class Centres	2. Deviation.	3. Number in Array of Type x	4. Observed Means of Butter Fat Arrays.	5.	6.
Type x	X	n_x	$\overline{y}_x$	$n_x\overline{y}_x$	$n_x\overline{y}_x X$
6·875	— 7	1	3·375	3·375	— 23·625
7·125	— 6	...	...	...	...
7·375	— 5	...	...	...	...
7·625	— 4	5	3·325	16·625	— 66·500
7·875	— 3	6	3·125	18·750	— 56·250
8·125	— 2	44	3·773	166·012	— 332·024
8·375	— 1	111	3·823	424·353	— 424·353
8·625	0	150	3·950	592·500	...
8·875	1	156	3·907	609·492	609·492
9·125	2	110	3·959	435·490	870·980
9·375	3	52	4·202	218·504	655·512
9·625	4	19	4·072	77·368	309·472
9·875	5	15	4·658	69·870	349·350
		669		2632·339	2794·806 — 902·752
		N		$\Sigma n_x y_x$	+ 1892·054 $\Sigma n_x y_x X$

$$\frac{\Sigma n_x y_x}{N} = 3 \cdot 934737$$

$$\frac{\Sigma n_x y_x X}{N} = 2 \cdot 828182$$

Let the required equation be of the form

$$Y = a_0 + a_1 X$$

From the above data, applying the method of least squares with other procedure not reproduced here, the constants a_0 and a_1 are determined, so that

$$Y = 3 \cdot 878586 + 0 \cdot 085569X.$$

This is the equation of the Line of Regression of y on x.

When $X = -7, \ Y = 3 \cdot 28$

When $X = +5, \ Y = 4 \cdot 31$

The line is drawn in Fig. 49 by joining the points (6·875, 3·28) and (9·875, 4·31). The value 6·875 corresponds to $X = -7$ and the value 9·875 to $X = +5$, as in Table 23.

The regression line as shown ascending to the right indicates positive correlation: had it descended to the right it would have indicated negative correlation. The greater the correlation the greater is the inclination of the regression line to the horizontal. The minimum inclination, 0°, shows that correlation is absent.

The regression of solids-not-fat on butter fat would be investigated as above, after transposing the two sets of variables, between the vertical and the horizontal, and calculating the means of the x arrays of y.

SAMPLING AND METHOD

Before beginning any investigation which involves the use of statistical methods, it is advisable to define clearly the aim of the study and to choose the statistical forms most appropriate to the problem in hand. An exhaustive review of the literature of the subject is a *sine qua non* if mere recapitulation of published work is to be avoided. Scrupulous accuracy should be observed in the collection and submission of data, and all preconceived ideas should be abandoned. The observer should follow wherever the facts may lead. He can, however, avoid certain common errors which arise from unrepresentative sampling of the events or characteristics under review.

Samples may be selected, or taken at random. In either event, it is necessary to avoid bias as, for example, the exclusion of cases which are deemed unlikely to support a preformed opinion of the observer. The sample should be fully representative of the population of events, called in statistical practice the universe, and it should include the largest possible number of units. The larger the sample, the more likely are its findings to be truly representative of the whole. Any system of sampling, however carefully arranged, is subject to error, including chance. It is therefore useless to argue a conclusion from sample findings unless due allowance has been made for the possible fallacies in computation.

Some indication of the degree to which the mean value of the sample is likely to differ from the true mean of the selected universe is afforded by applying the formula for the standard error of the mean

$$\text{S.E.} = \frac{\sigma}{\sqrt{n}}$$

where σ is the standard deviation of individual observations and n is the number of individuals in the sample. The value of S.E. is only relatively accurate when the sample contains less than 100 units. It depends both on the number of individuals in the sample and on the variability of the character under examination. The product of S.E. × 0·6745 is the Probable Error for the series.

In choosing samples it is convenient, as a basis for future comparisons, to select numbers which constitute a percentage proportion of the whole. It is then possible to derive a standard error of percentage. The relationship of the difference between an expected percentage of events and an observed percentage of the same events to the standard error of percentage serves to demonstrate whether such difference is likely or not to have arisen by chance. When d, the difference is greater than S.E. (%) × 2, it is said to be 'significant,' and therefore scarcely due to chance. When d is less than S.E. (%) × 2, it is classed 'not significant' and is regarded as possibly the effect of chance. It should be noted that no indication of the *origin* of the difference is given by the standard error procedure. It merely suggests that a causal factor other than chance is likely to be operative.

χ^2 (Chi-square)

It is frequently necessary in statistical work to show whether or not a relationship really exists between events or characteristics which at first sight appear to be related. The chi-square test is helpful in determining whether variations between what is observed and what is expected in a given series are due merely to chance. Thus the test serves to demonstrate a possible linkage between events while not necessarily indicating its strength. The method is exhibited in Table 24 which is intended to set forth the results following the use of seven different coryza vaccines upon seven different groups of persons. The problem is to determine whether the variations in the results are due to chance or to inherent differences in the vaccines themselves.

The calculation of χ^2 is based on the primary assumption that uniform success should be obtained in each group. The aim is then to measure the observed variation from uniformity, taking as the expected degree of success the percentage proportion entered at the foot of col. (7) and derived by calculating the percentage ratio of Σ col. (3) to Σ col. (2). Next, col. (4) is completed by applying to the total number of cases injected in each group the total expected percentage. Thus, for Group I., 53 per cent. of 140 is 74. Col. (6) is completed

TABLE 24.

PROPHYLAXIS OF CORYZA BY VACCINES[1]

Serial Number of Vaccine	Number of Cases Injected	Number of Cases in whom Coryza prevented		Number of Cases in whom Coryza not prevented		Percentage of cases in whom Coryza was prevented
		Observed Number	Expected Number	Observed Number	Expected Number	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
V I.	140	87	74	53	66	62
V II.	80	50	42	30	38	62
V III.	130	62	69	68	61	47
V IV.	200	90	106	110	94	45
V V.	70	43	41	27	29	61
Totals 5	620	332	(332)	288	(288)	53

by simple arithmetic. In Group I., for example, if 74 persons out of 140 may be expected to be coryza-immune, $140 - 74 = 66$ may be expected to be coryza-susceptible.

With the Table now completed in the manner described, we are in a position to note that the expression $\frac{(fc - fo)^2}{fo}$, in which fc stands for the calculated frequency of the cases and fo for the observed frequency of the cases, is a measure of the difference between the calculated and the observed frequencies in each group. When we add all the groups together, we get a measure of the difference between the total calculated and the total observed frequencies represented by the summation formula $\frac{\Sigma (fc - fo)^2}{fo}$, which is χ^2.

Group I. gives $\frac{(87 - 74)^2}{74} = \frac{169}{74} = 2 \cdot 2$. The procedure is the same for all groups, and for columns 5, 6 as well as columns 3, 4. The values emerging are $2 \cdot 2$ (as above) $+ 1 \cdot 5 + 0 \cdot 71 + 2 \cdot 4 + 0 \cdot 97 + 6 \cdot 9 + 1 \cdot 6 + 0 \cdot 8 + 2 \cdot 7 + 1 \cdot 1 = 20 \cdot 88 = \chi^2$.

Taking this figure to the χ^2 table drawn up by R. A. Fisher it is found to yield a probability of less than 0·01.[2] This means that the observed values differ from the calculated values to a greater degree than could be accounted for by chance. In other words, the difference is 'significant,' and suggests that certain of the vaccines are more effective than others.

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[1] Decimal points have been omitted for simplicity.

[2] For this interpretation of χ^2 see 'Statistical Methods for Research Workers.' R. A. Fisher. 7th Ed., 1938. Rather fuller values for χ^2 are presented in the Tables published by the Biometric Laboratory of University College, London.

When $\chi^2 = 0$ the agreement between the two sets of frequencies is perfect. When χ^2 is large the reverse is likely. Results have been found to depend to some extent upon the number of the groups. The more groups the better the fit, for the same value of χ^2.

IX.

FOOD

FOOD is the form of the material selected for assimilation in order to meet the tissue requirements for growth, maintenance and reproduction, and to supply the energy requirement for bodily heat, basic function and the performance of work. Assimilation is the process of digestion, absorption and transmutation of the relatively stable food material into the living substance.

NUTRITION

The nutrition of the individual depends not only on the quality and quantity of the food consumed, but it is also conditioned by many other factors, *e.g.* peace of mind and body, the quality and quantity of sleep, and freedom from distracting noise. The materials chosen as food should have as high a biological value as possible, that is, when the energy requirement is met, all essential nutrients should be present in optimal amounts in the food eaten.

The essential constituents of the food of Man are (1) Proteins, (2) Fats, (3) Carbohydrates, (4) Mineral Substances, (5) Vitamins and (6) Water.

Protein

Protein is man's chief source of N and S, and the phosphoproteins of milk and eggs form important sources of P during the growing period. Further, there is nearly always a certain quantity of fat and fat-soluble vitamins consumed with protein of animal origin, together with minerals and extractives which stimulate digestion. Vegetable protein is always associated with carbohydrate and generally with some members of the water soluble group of vitamins and mineral substances. Further, in some fashion, not entirely explained, protein tends to facilitate the absorption of Ca and P.

To subserve growth, maintenance, repair, reproduction and lactation is the primary function of protein. Secondarily, it is a source of energy. In virtue of its specific dynamic action it is peculiarly suited for those exposed to cold.

The proteins of ordinary food-stuffs are never present in single form, but as mixtures which vary in their biological value. It is well known that in their capacity to satisfy the nitrogen and sulphur requirements of the organism in all phases of its activity, proteins of animal origin such as those of milk, eggs, meat and viscera, are superior to the proteins of cereals and legumes taken singly, and that the superiority is more obvious when the proteins are used for growth than for maintenance. For this reason a classification into first and second class proteins, according to their origin from animal or vegetable sources, has been made in respect of these proteins. The difference between the two classes is in their amino-acids. They differ also in their digestibility, since the cellulose walls enclosing the vegetable protein offer resistance to digestion. Nevertheless, when a variety of plant foods is freely selected, the amino-acid requirements of the organism can, so far as is known, be met, and the essential difference between the so-called first and second class proteins largely disappears. To meet these requirements may sometimes involve increasing the total protein intake.

Various estimates have been made of the protein requirement of man. The Technical Commission of the League of Nations (1936) held that not less than 1 g. per kg. body weight should be present in the diet. Actual values found in freely selected diets tend to confirm this, and indeed all ordinary diets contribute at least this amount if the caloric requirements are satisfied. The League of Nations Commission values stated below are in accordance with the 1 g. per kg. principle.

It is advisable that a certain proportion of the protein should proceed from animal sources, and it has been recommended that at least a third should be so derived.

Fat

Fat is used essentially for energy purposes, and it is capable of being derived not only from food fat, but also from carbohydrate and certain amino-acids following their de-amination. Food fat, especially if of animal origin, is frequently accompanied by the fat soluble vitamins, chiefly A and D. Certain vegetable oils are associated with E and K. Animal experiments have demonstrated that some unsaturated fatty acids cannot be synthesised. How far this applies to man is unknown.

Fat is most convenient for storing energy within the body, in virtue of its high caloric value, lightness and storage without water, as well as its capacity for acting as a mechanical and thermal buffer. Hard muscle work, particularly in cold weather, generally calls for a more than proportionate increase in dietary fat. The inclusion of a large amount of fat diminishes the weight of total nutrient material which requires to be consumed to make good the energy expenditure.

For Arctic exploration, diets with a ratio of 1 : 2 : 2 for protein, carbohydrate and fat have been recommended. On the other hand, for work at high altitudes, very little fat is desired, and at levels of 17,000 to 23,000 ft. there is a very definite and progressive loss of appetite, and all solid food may become nauseating at still higher altitudes. Athletes in general raise their fat intake in direct proportion to their caloric expenditure. Carbohydrate is the immediate fuel for muscle work, but the body does not carry more than half a kilogramme of this at a time. Its replenishment results from the conversion of the de-amination residues of certain amino-acids and also of fats.

As a food constituent, fat tends to delay digestion and hunger is not so noticeable as when readily assimilable protein and carbohydrate constitute the bulk of the diet.

Following the first day or two, 13 per cent. of the energy expended during a period of starvation is derived from protein, the remainder from fat. The time of survival is measured largely by the fat reserves.

Carbohydrate

Carbohydrate forms the largest component of the diet of most peoples of the world and it furnishes most of the energy required. In this country it forms some 60—65 per cent. of the total energy value of the diet.

Provided they are lightly milled and have not been subjected to too much refinement, most cereals contribute quite considerably to the daily intake of certain mineral constituents and of the B group of vitamins. Further, they are our cheapest source of energy and, as bread, they form our ‘ elastic reserve.’ Potatoes are comparatively rich in vitamin C as are also most tuberous vegetables. They are not so rich in this vitamin as are leafy green vegetables, but their protein has a relatively high biological value, as was demonstrated in the recent War.

The consumption of an excess of sugar is to be condemned, since it tends to lessen in the diet the proportion of what have been termed the ‘ protective ’ foods. The term ‘ protective ’ has been applied to those natural foodstuffs which, when consumed in reasonable proportions, help to protect the individual from the effects of deficiency in any one or more of the essential nutrients which might otherwise readily occur in the particular area or country concerned. Such are dairy produce, eggs, and certain fresh vegetables and fruits.

Although cellulose is a constant component of vegetable cell walls, this carbohydrate cannot be assimilated to any extent by man. Its presence as residue in a mixed diet aids peristaltic activity of the intestine.

The rôle of sugar and sugar-rich materials in the production of dental caries has not been established. Glucose has been shown to be restorative to subjects on a high-fat low-carbohydrate diet, especially during hard work. This appears to be related to a restoration of the normal glucose level of the blood and its influence on the nervous system, rather than to its actual utilisation as fuel. The result is out of all proportion to the energy supplied.

Mineral Substances

Some 4·2 per cent. of the adult body is composed of mineral matter. The most important elements are sodium, potassium, calcium, magnesium, iron, copper, chlorine, phosphorus, sulphur and iodine, and probably manganese and zinc. They occur for the most part as salts and are essential for the normal functioning of all cells and the maintenance of the fluids bathing them. The organism's ability to resist deprivation of minerals varies according to their storage and the rôle they play. The acids which are constantly being produced from the catabolism of the sulphur- and phosphorus-containing moieties of protein are neutralised largely by the bases sodium and potassium. The partial exchange of ammonia for some of these occurs during excretion by the kidney. Mixed diets established by custom usually provide balanced intakes of acid and basic radicles, *e.g.* porridge is taken with milk, and meat with vegetables.

Sodium is the preponderating anion in the body's fluids and is mainly combined with chlorine. About 10 to 15 g. sodium chloride are ingested daily in the actual food eaten, most being added during the preparation of the food or at the table. In hot climates the salt may be increased by some 5 g. or more, particularly where sweat loss is considerable, for increased intake is a natural reaction provided there is no restriction in water supply. Where the latter is restricted, as in the desert, then reduction of salt intake is necessary despite loss in sweat, otherwise osmotic relationships are disarranged.

Men working under conditions of high temperature and drinking unsalted water may lose so much NaCl that muscle cramps or even collapse may result. The drinking of water containing 0·25 per cent. NaCl delays or prevents these symptoms.

Potassium. This element is the main anion of the cells of the body, being there largely as phosphate. It is abundant in plants and meat foods and therefore the danger of its deficiency is remote.

Calcium exists in the skeleton and teeth to the extent of some 99 per cent. of the total content of this element in the body. Some 75 per cent. of the body's total phosphorus and 70 per cent. of its magnesium are also laid down there.

The main effects of calcium deficiency are (1) inhibition of growth, (2) hyperplasia of the parathyroid glands, (3) hyper-irritability or tetany at levels below 7 mg. per 100 ml. serum, (4) rickets in the absence of sufficient sunlight or vitamin D and (5) maternal depletion in pregnancy and lactation. Foetal resorption has been noted to occur in pigs. In lactation, depletion tends to be limited by a diminution in the secretion of milk.

The absorption and retention of both Ca and P are dependent, among other conditions, upon rate of growth, ionic relationships between these two elements and others, the supply of vitamin D and protein level.

Although the child at birth is relatively Ca poor in order that delivery may be facilitated, nevertheless a certain store appears to exist in the trabeculae and this may be drawn upon during the first few months of post-natal life.

On the basis of standard average growth records, the daily requirement of retained Ca at 6 months is about 0·3 g. and rises as the child grows. In growing children retention of Ca becomes nearly equal to that absorbed. A pint of cow's milk supplies some 700 mg. Ca. The figure of 0·45 g. Ca per day for an adult has been accepted as the minimum and it has generally been supposed that this value should be increased by 50 per cent. The League of Nations allowances below are rather higher. Osteoporosis in varying degrees is common in older people, in part due to lowered intake and in part to diminished functional activity.

As regards pregnancy and lactation there are no satisfactory absolute figures for Ca requirement. In the light of our imperfect knowledge the League of Nations allowances are reasonable assessments. The organism possesses a remarkable capacity for maintaining the composition of the foetus and the milk in spite of adverse dietary conditions.

The richest sources of Ca are milk and cheese. The Ca of certain vegetables is poorly utilised: sometimes the oxalate content accounts for this. Drinking water may in some parts of this country contribute as much as 0·2 g. per day.

Bananas are said to improve Ca absorption. Hence their use in coeliac disease. In common with other plants they may play a part in increasing the utilisation of Ca from certain natural diets which are low in Ca.

Magnesium deficiency has never been noted in human beings, although some workers consider that intakes are on the borderline of requirements.

Phosphorus. There can be no doubt that in human dietaries phosphorus shortage is rare compared with lack of Ca, particularly in war time. In cereals however 50 to 80 per cent. of the phosphorus is in the form of phytic acid (inositol hexosephosphoric acid), which combines with the Ca present, rendering it non-utilisable. This effect on the Ca : P ratio can be countered by adding more milk or cheese to the diet. In Britain during the recent War 7 oz. $CaCO_3$ were added to every 280 lbs. flour. In some areas, depending on supplies, skimmed milk powder was added in the ratio of 2 lbs. per 280 lb. flour.

Iron, the fourth commonest element in the earth's crust, is present in our diets only in minute quantities, and iron deficiency is therefore of frequent occurrence. While its main function is in the formation of haemoglobin, it probably acts also as a catalyst of oxidation-reduction reactions.

The storage capacity is very considerable and the human organism at birth possesses a reserve which tides it over early infancy until solid foods are taken. Human milk contains 1 to 2 mg. per litre, cow's milk rather less.

In infants the mean haemoglobin level falls from its high value at birth to about the normal level at the third month. It falls again slowly in the following months, then rises, reaching adult figures at puberty. The mean of the adult woman is about 10 per cent. lower than that of the man.

There is no appreciable loss of iron in the urine, the control of iron balance being exerted through absorption or failure of absorption from the alimentary canal. Fourteen point six mg. per head per day is considered to be the post-war consumption target in this country.

Early work suggested that iron in the ferrous state was more readily absorbed, but the presence of a reducing agent such as ascorbic acid facilitates the absorption of even ferric iron, its reduction to ferrous taking place prior to absorption. 25 mg. medicinal iron in the ferrous state appears to be necessary per day to produce a 1 per cent. rise in haemoglobin in iron deficiency anaemia.

Children from the age of six months onward require their milk to be supplemented with iron and this can be most conveniently done by incorporating fine oat flour as a supplemental feed, oatmeal being relatively rich in iron. The iron requirement of man is chiefly met by vegetable matter, owing to its preponderance in diets. In general, vegetables with little chlorophyll have a low iron content. In decreasing order of iron content vegetables can be ranged thus: dried legumes, green leafy vegetables, dried fruits, nuts, cereals, roots, tubers from leafy plants. Egg yolk is a rich source of iron, and both in this and in vegetables the iron is in organic form.

Copper appears to facilitate haemoglobin formation in the human subject. A recent estimate put requirement at 2 mg. per day for the adult and 0·1 mg. per kg. per day for children between 4 and 6 years. *Manganese* probably plays a part in some oxidation-reduction systems. It acts as a coenzyme for arginase. *Zinc* is an essential constituent of carbonic anhydrase and is probably associated with insulin action. *Cobalt* is essential for ruminants and probably for other mammals. Its rôle in human nutrition is unknown but may be concerned with the re-utilisation of conserved iron compounds used in the formation of fresh haemoglobin.

Vitamins

Well defined signs and symptoms may follow deficiencies in any one of the following vitamins: others exist but their relationship to human nutrition has not been defined.

Fat Soluble .	A	...
	D_2	Calciferol.
	D_3	Activated 7-dehydrocholesterol.
	E	α-tocopherol.
	K	α-phylloquinone.
Water Soluble .	B_1	Aneurin. (Thiamin.)
	B_2	Riboflavin.
	B_6	Pyridoxin.
	P-P	Nicotinic Acid. (Niacin.)
	Folic Acid.	
	Other constituents of vitamin-B complex.	
	C	*l*-ascorbic Acid.

Vitamin A

This is a heavy viscid unsaturated alcohol containing a β-ionone ring. It is easily oxidised owing to its unsaturated nature, though in the absence of oxygen it is thermostable. As it is also destroyed by light its concentrates should be stored in dark bottles.

Vitamin A cannot be synthesised by animal tissues, but hydrolysis of one molecule of absorbed β-carotene, the principal carotene in carrots and green vegetables, should theoretically yield two molecules of the vitamin. The absorption and conversion of β-carotene is however defective, particularly in the absence of bile. Biological tests indicate that normally there is only an approximate 30 to 50 per cent. yield of vitamin A from carotene. This defect is naturally of importance when assessing the vitamin equivalent of the provitamins in the diet.

The conversion of β-carotene to vitamin A takes place in the liver. There also the vitamin is stored, possibly in the Kupffer cells. The liver can retain far more than the body's immediate needs. Deficiency is characterised by definite signs and symptoms. In adults and children night blindness is one of the earliest manifestations, and is frequently overlooked in infants and small children. It may be the only symptom of the deficiency. Reformation of visual purple and violet is slowed and sharpness of vision impaired. Measurement of dark adaptation, which depends on subjective responses, is on the whole unsatisfactory. This defect cannot therefore be accurately assessed. As the avitaminosis progresses, gross anatomical changes in the eyes are noted. Characteristic of this second phase are patchy dryness, thickened epithelium, loss of lustre, and wrinkling of the conjunctiva. There is decreased secretion of tears, and signs of deficiency may become apparent in other epithelial structures. In keratomalacia, which is the closing stage, the cornea softens, permitting bacterial invasion, and blindness is a frequent result. Occasionally these changes may be preceded by cuticular lesions. The skin becomes dry, the hair and nails are affected and keratotic papules arise from the pilo-sebaceous follicles.

Secondary results from the disturbance in the metabolism of epithelial membranes in vitamin A deficiency are interruption of growth and lowered resistance to bacterial infection. Involvement of the oral cavity is in part responsible for diminution in food intake in lower animals. It has been stated that the primary specific effect of vitamin A deficiency is 'the substitution of stratified keratinising epithelium for normal epithelium in various parts of the respiratory tract, alimentary tract, eyes, and genito-urinary tract.' With regard to the so-called anti-infective action of vitamin A there is no convincing evidence that the formation of antigens or antibodies is directly affected by its deficiency. Its rôle in resistance to infection is related to the maintenance of healthy mucous membranes.

Experimentally, vitamin A deficiency is difficult to induce in the human adult. Even after 7½ months on a deficient diet the only overt sign in the subjects tested was a low blood-carotene level.

Severe outbreaks of vitamin A deficiency are not common. The incidence of ophthalmia apparently due to lack of A is, however, relatively high in China, India and Labrador.

The international unit is the growth-promoting activity for rats of 0·6 microgram of pure β-carotene. One I.U. corresponds to 0·33 microgram of crystalline vitamin A in terms of growth activity.

The biological method is believed by some to be the most accurate for assaying vitamin A, but others have had less success. It is based on depleting rats of their reserves of the vitamin and then determining the dose of the test food that will produce the same growth response as a standard dose of vitamin A. The colorimetric method with antimony trichloride, and the spectrometric method, which depends on the intensity of an absorption band in the ultra-violet, are less reliable.

Standard League of Nations allowances for vitamin A are presented below. Recent observations by the Medical Research Council on human volunteers indicates that 2500 I.U. are sufficient for the adult, and that less may be required where much of the vitamin is pre-formed in the diet. These requirements may be lower than the amount stated if the vitamin is obtained primarily from animal sources such as milk and milk products and certain meat foods. If obtained largely from vegetable sources, greater amounts are stated to be desirable. Fish liver oils such as those of the cod and halibut are our commonest rich natural sources of the vitamin. Dairy products such as butter, milk and cheese are good sources, as are also egg yolk, liver and pigmented and leafy vegetables, including carrots, tomatoes and greens. The milk of cows on summer pasture has a higher content than at other times. Margarine is at present fortified with vitamin A to a value of 550 I.U. per oz. Fortification of edible fat is carried out in the U.S.A.

Vitamin D

The most important related thermostable substances which possess the property of healing rickets are Vitamins D_2 (calciferol) and D_3 (activated 7-dehydrocholesterol). At least nine other derivatives have antirachitic properties. The compound D_3 occurs in fish liver oils which are the richest natural sources. It is present also in eggs, butter, milk and tissues exposed to sunlight or ultra-violet light. The change from dehydrocholesterol to D_3 in the mammalian organism appears to require ultra-violet radiation and would normally occur at surfaces of the body exposed to sunlight. Clothes, smoky atmospheres and latitude affect the amount of such radiation. D_2 and D_3 have equal values for man.

Plant foods are practically devoid of vitamin D, and animal sources are of very limited distribution, egg yolk being one of the richest sources. Recent work has now shown that herrings and salmon do not appear to contribute significantly to the daily human intake.

In vitamin D potency, 5 eggs are equivalent to one teaspoonful of cod liver oil. Cow's milk is low in vitamin D, and human milk is little better. In this country, but not in the U.S.A., margarine is fortified with vitamin D to the extent of 60 I.U. per oz. In virtue of its Ca and P contents, milk itself forms an excellent medium for fortification with vitamin D. The Council on Foods of the American Medical Association have decided that milk is the only common food which will be considered for fortification with this vitamin.

Rickets is ordinarily observed in infants between the ages of 6 months and 2 years, but may occur at later ages, and adolescent and adult forms have been found. It still exists in large cities: 25 per cent. of the children under 18 months admitted to a large Glasgow hospital were found to show radiological evidence of the disease. The osteomalacia of pregnancy and lactation is a form of adult rickets.

Skiagrams of hand, wrist, elbow and hip provide evidence of this deficiency. The inorganic phosphorus content of the plasma or serum may in rachitic children be reduced to 3 mg. or less. The plasma phosphatase is increased considerably, as in nearly all generalised bone disorders, and may form the most reliable biochemical sign.

The body is able to maintain a reserve of vitamin D, the amount depending upon the dietary supply and reserves in the body fat, and on the extent of exposure to ultra-violet radiation. The need for vitamin D appears to be conditioned by the Ca : P ratio in the diet, which should normally be between 1 to 2 : 1. No one has as yet succeeded in demonstrating the production of rickets on a vitamin D deficient diet provided the ratio of assimilable Ca : P is of the above order. The value of vitamin D would lie in its capacity to prevent rickets occurring when the diet is ill-balanced in respect of Ca and P. The presence of considerable amounts of cereals in the diet may lessen the absorption of calcium owing to the formation of insoluble compounds with phytic acid. There is more phytic acid in higher extraction flour. The deleterious excess can be countered by raising the dietary level of Ca, but at the present time most diets contain enough Ca and vitamin D to prevent rickets. Groups which should receive special protection are pregnant and nursing women and growing children. Abnormalities of tooth formation, which may later lead to caries, may owe their inception to an insufficient supply of calcium and vitamin D to the mother during her pregnancy.

Vitamin D appears to bring about maximal utilisation of Ca and P under unfavourable Ca : P ratios, but its exact action is unknown. Some hold that Ca plays a secondary rôle to P in the disordered metabolism of rickets. It is generally held that feeding vitamin D in amounts above the minimum levels considered necessary for the prevention or cure of rickets has no harmful effect.

The international unit (I.U.) corresponds in anti-rachitic activity to 1 mg. of standard irradiated ergosterol solution, or 0·025 microgram of calciferol or irradiated 7-dehydrocholesterol. The vitamin D requirements for the child, adolescent and adult are unknown.

As there is no chemical method for the assay of vitamin D potency, bio-assay must be performed. The deposition of bone as revealed by the examination of bone sections stained with $AgNO_3$, or skiagraphs of the bones of the living rat, or determination of the ash content of bones, after a suitable interval following administration of vitamin D to test animals, are the main methods. When split sections of the bones of rats used for assay are treated with $AgNO_3$ exposure to light causes a blackening of the newly calcified areas.

Vitamin E

Vitamin E is α-tocopherol. Several tocopherols are known, but α-tocopherol is the most active. This vitamin is unstable in the presence of rancid fats, but is not destroyed in ordinary cooking processes. Wheat germ and green leaves of lettuce are excellent sources. Egg yolk, milk and butter also contain it.

Although there are indications that vitamin E may play a rôle in human nutrition, the evidence is not convincing. It has however been suggested that human requirements are in the region of 3 mg. per day.

In lower animals, both male and female, α-tocopherol appears to be specifically concerned with reproductive functions. Nutritional muscular dystrophy in rabbits and rats can be prevented or cured by this compound, but clinical experience with neuro-muscular disease in the human subject reveals no significant difference in the course of treated and untreated cases.

Vitamin K

Vitamin K, or α-phylloquinone (2-methyl-3-phytyl-1 : 4-naphthoquinone) is essential for the formation of prothrombin, which failing through default of absorption or possibly by deficiency in the diet, induces a prolongation of the 'prothrombin time' and a tendency to haemorrhage. Many analogues to vitamin K are known to have a similar action.

Human beings obtain their vitamin K from their diet and by bacterial synthesis in the intestine. Bile salts appear to be necessary for the absorption of K from the intestine. In clinical conditions where bile does not reach the intestine, no absorption takes place. K deficiency also tends to result in those suffering from impaired liver function. The vitamin is used in the pre-operative treatment of patients exhibiting jaundice.

During the first four days of life a fall in prothrombin level is noted, but this is soon followed by a rise when breast milk becomes abundant. Dried cow's milk (5 to 10 g.) in water, fed to infants on the third or fourth day of life induces a good prothrombin response.

Vitamin K is present in the green leaves of vegetables, *e.g.* cabbage, cauliflower and kale, and less abundantly in tomatoes, potatoes and liver oil. It is synthesised in the intestinal tract of animals by bacterial action. Human requirements are unknown.

Vitamin B_1

Vitamin B_1, or aneurin, or thiamin, is built up from a pyrimidine and a thiazole nucleus. In combination with pyrophosphate it acts as the co-enzyme co-carboxylase in the decarboxylation of pyruvic acid, apparently an essential stage in the intermediary metabolism of nerve and other cells.

This vitamin is essentially of plant origin and its presence in milk, eggs and liver depends on dietary intake. It is found in seeds, leaves, roots, stems and fruits. In cereal grains it is in highest concentration in the germ, next in the bran, and least in the endosperm. Wheat germ, nuts, yeast, egg yolk, liver, pork, ham and legumes are richly stocked. Whole wheat bread, oatmeal and other cereals and potatoes are good sources.

Aneurin is lost to a variable extent on cooking. While carrots suffer no change on boiling, potatoes lose about one-third of their content. Wheat flour loses about 14 per cent. of its aneurin content when baked into bread. Roasting of pork causes a loss of 57 per cent. Boiled potatoes and cooked carrots each furnish amounts of aneurin per serving comparable with those supplied by cooked cereal or a slice of whole wheat bread. Canning or pressure cooking of vegetables, if of short duration, causes little or no loss. Exposure to SO_2, though apparently preserving carotene, destroys aneurin.

The symptom complex of beri-beri, which is essentially a B_1 deficiency, is peripheral neuritis, cardiac insufficiency and generalised tendency to oedema.

It has been stated that the daily excretion of 100 micrograms aneurin or more, together with 20 per cent. or more of a test dose of 1 mg. given subcutaneously, constitutes dependable evidence of normal nutrition. One mg. pure vitamin B_1 hydrochloride (anhydrous) = 333 I.U.

Standards of allowance are provided below, but it is necessary to note that the aneurin requirements are not so precisely known as might be indicated by these figures. In this country the replacement of 75 per cent. extraction flour by 85 per cent. extraction raised the aneurin content of the flour sufficiently to meet nutritional requirements. Recent work suggests an allowance of 0·66 mg. per 1000 non-fat calories. The Ministry of Food's recent conference on the post-war loaf has suggested that our target should be 1·78 mg. per head per day.

Vitamin B_2

Vitamin B_2, more commonly called riboflavin, combines with complex organic phosphates to form co-enzymes which, united to specific proteins, form important oxidising enzymes. It is highly heat-stable, surviving canning, and is stable also to oxidising agents including halogens.

It is most abundant in milk, egg white, liver, pancreas, kidney and leafy vegetables. Other good sources are beef, veal, chicken, apricots and tomatoes.

As natural deficiency lesions are nearly always of multiple aetiology it follows that pure uncomplicated ariboflavinosis is virtually unknown. Experimental ariboflavinosis in the human subject has produced no subjective or objective changes even after six months on the restricted régime.

At one period it was thought that vascularisation of the cornea was a specific sign of ariboflavinosis, but now it is known that not all increased vascularity of the limbus and cornea is due to this deficiency. It has been held that the extensive vascularisation of keratitis rosacea is associated with ariboflavinosis and responds to the administration of this vitamin (10 to 50 mg. per day). Magenta glossitis, cheilosis and seborrhoeic lesions in folds of the face and skin have in general been held to be due to this deficiency. In most pellagrins there is a co-existent ariboflavinosis. There is no international unit.

The standard allowances are given in Table 25, but these values are primarily intended to show how the requirement varies with the caloric requirement and not as absolute values, for the requirements are virtually unknown. Methods of assay are by rat growth effects, and by fluorimetric or microbiological studies. Riboflavin is added to wheat flour in America. The target for post-war Britain has been assessed at 1·92 mg. per head per day.

Vitamin B_6

Vitamin B_6, or pyridoxine, is 2-methyl-3-hydroxy-4.5-dihydroxyl-methyl-pyridine. It has been called the anti-dermatitis vitamin but no clear cut symptoms resulting from its deficiency have been described in man. It may be one of the factors whose deficiency contributes to the syndrome complex of pellagra. Rich sources include yeast, wheat germ, roe, liver, rice polishings and pulses. Additional sources are milk and vegetables.

Vitamin P-P

Vitamin P-P, more commonly called nicotinic acid, or niacin, is known as the pellagra-preventive factor. Other pyridines have this action. Nicotinamide is also physiologically active. Like riboflavin, nicotinic acid forms part of a complex enzyme system. It is a constituent of co-enzymes I and II which act as transporters of hydrogen from metabolites to molecular oxygen. Like B_2, it is one of the most thermostable components of the B complex to which it belongs. Pork, beef, lamb, liver and kidney, roast beef and yeast are among the richer sources of this vitamin.

Pellagra is a multiple deficiency disease and nicotinic acid is only one of the vitamins which are deficient. It occurs amongst all races. It is a disease of poor people in rural districts with limited choice of food. 95 per cent. of cases have their onset between April and July with remissions in late autumn and winter. It is generally confined to warm climates.

The most typical symptom is erythema. Later the skin of the hands and feet becomes rough and scaly. Other parts frequently attacked are the neck, face, elbows and knees. Accompanying it there is soreness of the mouth, redness of the tongue, indigestion and diarrhoea, as well as mental disturbances.

Recognition of sub-clinical nicotinic acid deficiency is still dependent upon routine clinical observation and in consequence its true incidence is very difficult to determine.

Sebrell considers that the essential points in the dietetic treatment of pellagra are: (1) 1 quart of milk daily: (2) 3000 to 4000 Cal. in addition to milk and lean meats, liver and other foods rich in this vitamin: (3) not less than 30 grams and up to 200 grams or more daily of pure dried yeast: (4) liver extracts administered either orally or parenterally.

The addition of nicotinic acid as a dietary supplement in pellagrous regions, while it may prevent the disease, is not the most desirable way to remedy this condition, since the diet is generally lacking in other essentials. It is considered that the post-war level for Britain should be 13·9 mg. per head per day.

Folic Acid

This vitamin is present in liver, yeast and certain other foods. A synthetic acid has been prepared. It is N-[4-(2-amino-4-hydroxy-6-pteridyl) methyl amino benzoyl]] glutamic acid. It appears to act as an enzyme or co-enzyme which sets in motion the system for the production of the liver principle responsible for normal haemopoeisis. This synthetic compound is therapeutically active, when given by the mouth or parenterally, in the treatment of many macrocytic anaemias including pernicious anaemia and sprue. It is apparently not effective in iron-deficiency anaemia, aplastic anaemia and leukaemia.

Other Vitamin D Components

Little is known about the actual function of pantothenic acid, and the nature of pantothenic deficiency, if it ever occurs in man, is completely unknown. The same is true of biotin. Choline deficiency has been thought to be a contributory factor in human liver cirrhosis. The function of inositol in the organism is still unknown. It appears to have lipotropic activity, so preventing or removing the condition of fatty liver.

Vitamin C

Vitamin C, or *l*-ascorbic acid, is freely soluble in water and its sodium salt is frequently used parenterally. It appears to act as a hydrogen transporter and functions as a component of a physiologically reversible oxidation-reduction system. Ascorbic acid $\rightleftharpoons$ dehydroascorbic acid.

Vitamin C is widely distributed in plants and animals. It is rapidly formed in sprouting seeds and in fast-growing stems and root tips and in all green leaves, fresh fruits and tubers. It is present in almost all glandular organs and in least amount in muscle and stored fat. Cow's milk is poorer than human milk in its content of this vitamin. Visible light appears to have a destructive action on it. In an inert atmosphere it is quite stable to moderate heat, even when the reaction of the milk used is alkaline, but in the presence of oxygen destruction by heat is rapid when the pH is over 7. In acid media such as citrus fruits it is stable even in the presence of oxygen. Vitamin C may be lost in the blanching or thawing of frozen foods, also in the drying and dehydrating of fruits and vegetables. Citrus fruits and tomato juice may be canned without loss of ascorbic acid. There is no loss of this vitamin on boiling potatoes for 35 minutes: a serving of fried or baked potatoes, or about 150 g. or one medium sized potato will provide from 14 to 25 mg. ascorbic acid. There is evidence that the ascorbic acid content of potatoes is largely destroyed by mashing them.

Vitamin C appears necessary for the formation of all intercellular tissues having collagen, or collagen-like substances, as their basis. Collagen is the foundation of all fibrous structures, the matrices of bone, dentine, cartilage and all non-epithelial cement substance, including that of the vascular epithelium. The teeth, bones and blood vessels are chiefly concerned.

In man, deficiency of ascorbic acid seldom occurs unaccompanied by other inadequacies or imbalance. Scurvy is the outstanding disease associated with this shortage. The symptom complex of the condition is noted elsewhere.

The ascorbic acid requirement is augmented by all diseases in which there is an elevated temperature. The types of diet which have been used in the past for the treatment of gastro-intestinal ulcers have generally contained too little C.

Various tests have been proposed for the estimation of sub-clinical scurvy but none is fully satisfactory. Probably the most promising is the ascorbic acid tolerance test in which the urinary excretion of ascorbic acid is followed after the ingestion of 10 mg. per kg.

The international unit is 0·05 mg. *l*-ascorbic acid. The chief methods for its assay are (1) dye indicator, (2) furfural colorimetric, (3) methylene-blue decolorisation, (4) enzymatic, and (5) guinea pig protection.

The allowance per head per day would appear to be of the order of 30 mg.

Water

This is the most important of all dietary components and survival beyond a few days is impossible in its absence.

In temperate climates about 2 quarts should be drunk and in hot climates 4 to 8 or more times this quantity may be taken. The main point is to make certain that the urinary output does not fall below 1 pint.

DIETARIES

The Calorie value of the diet required by the individual is determined by the amount of energy which he expends. Account must also be taken of the food used in the processes of growth, reproduction and lactation. Assuming, as calculations warrant, that the total energy expended in the course of a day by the average man engaged in moderately active muscular work is approximately 3000 calories, we deduce that his daily diet must suffice to supply him with 3000 calories available to him, which we call Calories *net*. Since, however, waste in cooking and assimilation involves a loss of some 10 per cent., the Calorie potential of the diet should be 3300 Calories as purchased, which we call Calories *gross*. The total Calories of the diet are made up of the Calorie values of its dynamic constituents. These values are derived for each from its biological Calorie factor, as shown :

	Calories per Gram.
Protein	4
Carbohydrate	4
Fat	9

Sex and age will obviously affect the energy output of the body and the material stored and therefore the Calorie content of the appropriate diet. In Table 25 presenting 'estimated daily requirements' it will be observed that the Caloric values differ as between men and women and also according to the ages of the children. The table takes account also of conditions which demand a special expenditure of energy, the food Calorie figures being moved up so as to provide it. Active and very active persons are awarded more Calories than those who lead sedentary lives. In the case of women there are corresponding adjustments designed to fit them to encounter the stresses of pregnancy and lactation.

The basal energy expenditure of the average woman, due mainly to her slighter musculature, is below that of the average man. In children from birth up to 5 years there is a steady rise of the basal metabolic rate. Thereafter it falls to the age of 20 : from 20 to 50 it is approximately constant : after 50 there is a slow decline. In most dietary calculations the problem is not the 'average man' alone, but the man together with his wife and family, and coefficients have accordingly been devised to represent the relative energy requirements of the various members of the households. They are generally expressed as decimal fractions of the energy requirement of the average man and are called 'man values.' These coefficients designed on an energy basis do not hold when one is considering a dietary constituent such as calcium, which is bound up with skeletal development, and not with energy requirements. The requirements of adolescence for energy have in the past been underestimated.

A general review of diets throughout the world allows of their separation into three chief groups, but all grades of intermediate levels may be found. The diets in the first group are essentially animal in origin, consisting necessarily of fat and protein, with only a small amount of carbohydrate. Such diets are to be found amongst hunters and fishers, *e.g.* Eskimo, Lapp, Samoyed, Fuegian, and amongst pastoral nomads, *e.g.* Khirghiz, Masai, Somali. Availability largely dictates the diet consumed. In the second group the diet is of mixed plant and animal origin. Such diets are consumed in Europe and European settlements, *e.g.* the Dominions and North America, and by certain Asiatic and African tribes. The third type of diet is mainly vegetarian. Largely owing to pressure of population and primitive farming methods, the indigenous populations of India, China, inland regions of the East Indian Archipelago, African Colonies, etc., are forced to consume a diet which is essentially plant in origin, being mainly composed of carbohydrate with little fat. Although very low or devoid of animal protein, the total amount of protein actually consumed may be comparable with that found in mixed diets.

TABLE 25.

ESTIMATED DAILY REQUIREMENTS OF NUTRIENTS PER HEAD
League of Nations Commission

Age in Years.	1–3	3–7	7–12	12–15	15–17	17–21	Males 21 + Average	Females 21 + Average	Expectant & Nursing Mothers
Calories . .	1100	1500	2100	2900	3000	3000	3000	2500	3000
Protein gms. .	42	50	65	95	100	90	70	60	80
Calcium gms .	1·1	1·3	1·4	1·5	1·4	1·1	0·8	0·8	1·5

MALES.	
Sedentary work .	2400
Light „ .	2700
Moderate „ .	3000
Hard „ .	3600
Heavy „ .	4000

FEMALES.	
Sedentary or Light work .	2400
Moderate „ .	2700
Hard „ .	3000

The demand for energy is primary, and the yield of food energy from an acre of land is higher for cereal crops than for legumes in the ratio of about 3 : 1, and higher than for meat produced from the crops in the ratio of about 9 : 1. Hence, where pressure of population is heavy, the consumption first of animal products and then of leguminous plants tends to fall, and the consumption of cereals, and in consequence carbohydrates, rises markedly.

If we discount extreme cases, particularly those who are by circumstances meat consumers, the percentage of the total energy derived from protein is about the same, generally between 10 and 14 per cent. The percentage of energy derived from fat is much more variable and is in inverse proportion to that derived from carbohydrate. Economic pressure lowers fat and raises carbohydrate consumption, because carbohydrate is cheaper than fat. A cross section of the population of St. Andrews may be taken as representative of the situation in pre-war Britain at its best.

GRAMS PER MAN VALUE (CATHCART-MURRAY) PER DAY

Protein.	Fat.	Carbohydrate.	Calories.
84	119	407	3120

Of the total protein 54 grams are from animal and 30 from plant sources.

A Ministry of Food estimate of the caloric requirement per head per day in Britain is put at 2750 Cal. This level probably conforms to that available in areas containing somewhat less than a third of the World's population. In areas containing over half the World's population, food supplies at the retail level (not actual intake) have been estimated to furnish an average of less than 2250 Cal. per head per day. The remaining sixth show intermediate values.

Many of the low-calorie countries are in the tropics and subtropics. In these countries food energy requirements may be less than in colder countries. The people, on the average, are usually smaller. The proportion of children in the population is usually greater. These factors, however, cannot account for the great difference in *per caput* daily caloric intake between the low and high countries. There is insufficiency of food in these places.

In general, it may be said that, whenever and wherever economic circumstances permit, man elects to raise his intake of animal protein to the region of 60 per cent. of the total protein. This qualitative change may be accompanied by a slight rise in the total proportion of protein. But, if the diet was previously wholly or largely vegetable in origin, there may be a reduction in the proportion of the growth energy from protein. This qualitative change in protein intake is generally also accompanied by an increase in the consumption of animal fat and diminution in carbohydrate intake. How far these qualitative changes are determined by a real need for protein and fat of animal origin, or for other dietary essentials associated with these in animal foodstuffs, it is impossible to state. There is no doubt that the attractive flavour of animal protein and fat, and in the case of protein its more easy assimilation, are contributing factors. It may be that in such a diet protein and fat form more effectively an optimal metabolisable mixture with carbohydrate.

In view of the declining birth rate, together with the service and civilian losses of the Second World War, attention is being strongly centred upon the protection of the lives and welfare of the new generation now coming into being, in order that they may survive and reach adult ages numerous enough and fit enough to serve the need of their country in the years to come. Hence the special importance now attached to the selection of the best available diets for (1) Expectant Mothers, (2) Nursing Mothers, and (3) Children.

For expectant mothers the requirements which need special care are protein, calcium and iron. Gastric disorders may markedly lower the intake level. Where the diet is ill-balanced in respect of Ca and P cod liver oil may protect against rickets.

With nursing mothers the secretion of milk reaches its peak about the 7th month when one litre is the approximate daily requirement for the infant. This volume contains 15 g. protein, 35 g. fat, 70 g. carbohydrate (total Cal. 600) and 0·3 g. of Ca. Sometimes the milk yield is greater. The diet of the mother should contain at least a quart of milk per day together with a general increment in total food intake, so that the caloric requirements are met. If the diet should be unsatisfactory in respect of milk supply it may be wise to protect with cod liver oil.

As regards children there is no doubt that the breast fed child, provided it gets sufficient milk, is the better nourished. After six months, supplementation with cereals prevents iron deficiency in the infant. In the artificially fed, vitamin C is necessary, as cow's milk is low in this vitamin and heat treatment reduces its content still further. Cod liver oil should not be necessary if the supply of milk is sufficient, but where it is insufficient the oil will protect against rickets. The main problem is to ensure that children get sufficient good food, particularly milk and fresh vegetables. It is when a child is undernourished that disease is liable to occur. General malnutrition, iron deficiency and rickets are still far too common.

Under war conditions the demand for calories is supreme: protein, vitamins and minerals must assume a secondary rôle. Moreover in restoring normality there is no substitute for a good diet of ordinary foods. Vitamin concentrates or synthetic vitamins and mineral concentrates should not be used when natural food sources are available in adequate amounts. The dairy and the green-grocer's shop are the proper places to obtain the bulk of our vitamins. When staple foodstuffs are for any reason nutritionally inadequate they must be made adequate by whatever means are most sound from the stand-points of nutrition and economy. We have two good examples at the present moment. The higher extraction of the wheat grain has rendered it unnecessary to add vitamin B_1 to the flour as was originally contemplated, and the addition of vitamins A and D to margarine has countered the butter shortage. The needs of pregnancy and lactation and the requirements of children, referred to above, may demand special schemes for the provision of cod liver oil, good natural sources of ascorbic acid, and especially of milk.

The ravages of war have been succeeded by droughts, floods and other catastrophies. The 'mellow light of victory' has revealed the spectre of starvation in Europe and in the East. Drastic action has been necessary in order to avoid famine leading to death on a gigantic scale. The continuing need is for wheat and rice in large quantities for immediate distribution. In general, it has been found that the water-soluble vitamins can be obtained by eating crude vegetable matter and that the body's resources of fat-soluble vitamin can tide over emergencies which are not too prolonged. It is this body reserve of fat which largely determines the period of survival in times of famine.

FOOD CONTROL

Public control over the quality and wholesomeness of food is exercised by means of acts, orders and regulations which are usually due to be administered by local authorities. It is desired to ensure that food shall be sound and genuine, and that it shall not contain any added extraneous material, either animate or inanimate, the presence of which may react to the detriment of the consumer.

As regards the soundness of food, under the Food and Drugs Act, 1938, it is an offence in England to sell or expose for sale, or possess or deposit or consign for the purposes of sale, any food intended, but unfit, for human consumption. An authorised officer of a local authority may at all reasonable times examine any such food intended for human consumption, and if it appears to him to be unfit for human consumption he may seize and remove it in order to have it dealt with by a justice of the peace. The officer must inform the person in whose possession the food was found of his intention to have it so dealt with, and the person will be entitled to be heard by the justice. If a justice is satisfied that any food brought before him, whether under these provisions or not, is unfit for human consumption, he must condemn it and order it to be destroyed or so disposed of as to prevent it from being used for human consumption. Similar procedure may be adopted with food in a vehicle or container intended for sale for human consumption or in course of delivery after such sale, if found unfit. If the justice has condemned and the case is taken to Court the person responsible is liable on conviction to fine or imprisonment. If the justice has refused to condemn, the local authority must compensate the owner.

In Scotland the equivalent procedure is as provided for in the Public Health (Scotland) Act, 1897. Any medical officer or sanitary inspector or veterinary surgeon approved by the local authority may search any cart, vehicle, barrow, basket, sack, bag or parcel, and may inspect any animal whether alive or dead and any article whether liquid or solid, intended for the food of man and exposed or deposited or in course of transmission for the purpose of sale, and if any such animal or article appears to him to be diseased or unsound or unfit for the food of man he may seize it and carry it away to have it dealt with by a sheriff, magistrate or justice of the peace. If it is a living animal a veterinary surgeon must be called in. If it appears to the sheriff, magistrate or justice that the animal or article is diseased or unsound or unfit for the food of man he must condemn it and order it to be destroyed. The person concerned is liable on conviction to a fine up to £50 for every animal, article or parcel unless he can prove that he did not know and could not reasonably have known that it was in such a condition. In a sheriff court if the sheriff finds that the offence was wilful the penalty may be imprisonment with or without hard labour.

As regards the genuineness of food, under the Food and Drugs Act, 1938, no person in England may, with intent to sale, add or permit or direct to be added any substance to any food so as to render the food injurious, or any substance to any drug so as to injure its quality or potency, and no person may sell or have in his possession any food or drug so treated. No person may, with intent to sale, abstract any constituent from any food so as to injure its nature, substance or quality, without notice to the consumer or in contravention of regulations. No person may sell to the prejudice of the purchaser any food or drug which is not of the nature or substance or quality of the food or drug demanded. It is no defence for the vendor to say that the purchaser bought for analysis and therefore was not prejudiced. The Food and Drugs Authority must appoint a public analyst for the examination of samples of food and drugs. The samples are taken by an authorised officer of the local authority, usually by purchase. Immediately after purchase the officer must inform the vendor that the sample has been obtained with a view to analysis. It is then divided into three parts, one for the vendor, one for the authorised officer and one for transmission to the public analyst. If the analyst's certificate is to the effect that the food or drug is not genuine the vendor is liable on conviction to fine or imprisonment. If however the vendor can prove that he purchased the food or drug under a written warranty, and that he sold it in the same state as he got it, it is a defence. Other special provisions including what is known as 'the appeal to the cow' affect milk sampling.

For Scotland the equivalent provisions are set forth in the Food and Drugs (Adulteration) Act, 1928. No person may, with a view to sale, mix, colour, stain or powder any food so as to render it injurious, or sell any food which is not of the nature, substance or quality demanded by the purchaser, or mar any food by abstracting a part of it. The appointment of a public analyst is obligatory as in England, and the arrangements for sampling are on the same lines in both countries, except that in Scotland a warranty is no defence in prosecutions relating to milk, cream, skimmed milk, separated milk or butter milk, and that the 'special provisions' affecting milk sampling do not apply.

The law lays down standards for the composition of various foodstuffs. With a view to the exclusion of communicable disease from milk, veterinary inspectors are appointed to examine dairy cows. With the object of excluding diseased meat from the markets, meat inspectors examine the carcases of meat animals at the time of slaughter. Among other important matters dealt with by regulation are the addition of chemical preservatives to foods, and the prevention at ports of the importation of diseased or unsound meat into this country from overseas.

MILK

Cow's milk is the complete natural food of the youngling calf. It can conveniently be given to the human infant as a substitute for breast milk, with which it has much in common. In view of its full content of the essential food constituents cow's milk has an important further use as an addition to the diets of persons above the age of infancy.

The normal composition of cow's milk as compared with human milk is shown in Table 26. The protein is higher in cow's milk, mainly owing to high caseinogen, which is six times that of human milk. Lactose on the other hand is lower. The milk fats in the two kinds do not greatly differ. Another substantial divergence is that of the minerals, which are nearly four times higher in cow's milk. The mean specific gravity of cow's milk is 1032. The yield of milk from a healthy cow is 2½ to 3 gallons daily. The average milking life of a cow is 4½ to 5 years.

TABLE 26.

PERCENTAGE COMPOSITION OF MILKS

	Cow's Milk.	Human Milk.
Protein . . .	3.5	1.7
Lactose . . .	4.8	7.5
Milk Fat . . .	3.7	3.5
Minerals . . .	0.7	0.2
Water . . .	87.3	87.1
	100.0	100.0

The proteins of cow's milk are caseinogen, lactalbumin and a trace of lactoglobulin. They contain all the amino-acids requisite for nutrition and are among the most valued of the first-class proteins.

Lactose, the milk sugar, is a disaccharide, $C_{12}H_{22}O_{11} + H_2O$, less sweet and less soluble in water than sucrose. Under bacterial action it yields lactic acid, which causes the milk to sour and later to curdle.

Milk fat consists of myristin, palmitin, olein and stearin with smaller proportions of butyrin and other glycerides of the fatty acids. Fat is high in the milk of Jersey and Guernsey cows, low in that of Holstein-Friesians. An intermediate position is held by Ayrshires, Short-horns and Devons. Evening milk is richer in fat than morning milk, and winter milk richer than summer milk. The 'fore-milk,' or first milk drawn, is weak in fat: the 'strippings,' or last milk drawn, consist chiefly of fat. Good milk should contain from 3.5 per cent. of fat upwards.

The vitamins A, B_1, B_2, C, D and E may all occur in cow's milk, but A, C and D, which are the most important, are subject to seasonal fluctuations, being high in summer when the cows are out at grass, and low or absent in winter when they are stall fed. Vitamin A is in part at least derived from the carotene of the green pastures. The coloration of milk is mainly due to carotene. Rapid drying at 200° F. enables summer grass to retain its carotene for winter feeding. It is probable that the vitamin D of summer milk is mainly synthesised by the sun-bathed cow from her own ergosterol, but a milk rich in vitamin D may be obtained in any season by feeding cows with irradiated yeast or irradiated ergosterol, or the vitamin may be generated in the milk itself by irradiation after withdrawal.

The mineral elements of cow's milk include Ca, P, K, Na, Mg, S, I, Cl, Fe and Cu. The calcium and phosphorus are in correct adjustment. The quantity of calcium is 0·12 per cent., or six times that in human milk, which is 0·02 per cent. This excess calcium represents the more rapid rate of bone formation in the more quickly growing calf. The iron present is 0·0002 per cent. or less: the copper 0·000005 per cent. or less. In the dilution of cow's milk for infant use in order to lower the excess minerals and protein, the normal iron and copper of the milk, which are present only in traces, may readily be depressed below the requirements of the infant for haemoglobin production. Hence the greater degree of anaemia in hand-fed infants than in breast-fed infants noted by Helen Mackay.

Use of Milk

In the second half-year of life the calcium requirements of the infant become greater than can be supplied by mother's milk alone. Soon the child can utilise more than double the amount of calcium available from this source, and cow's milk with its high mineral concentration is well adapted to satisfy the increasing demands.

In later childhood also, when bone formation continues active, the administration of cow's milk as an addition to the ordinary food stimulates growth and development. Corry Mann in a boys' school where the basic diet appeared adequate gave to a group of boys for a period of four years 1 pint of milk daily over and above their ordinary food. At the end of the time this group showed increase of stature and weight, and an access of high spirits, greater than in the boys to whom no added milk was given. Again in 1926-27 and 1927-28 under the charge of the Scottish Board of Health a thousand school children, separated into four groups, were treated as follows: Group 1 received an allowance of whole milk in addition to their home diet: Group 2 got skimmed milk: and Group 3 biscuit, while Group 4 had no addition. In both years Groups 1 and 2 put on more weight and added more to their stature than Groups 3 and 4. Further, Groups 1 and 2 did equally well, indicating that the energising substance was not in the milk fat and therefore could not be a fat-soluble vitamin. The explanation which fits is that in the home fare of the children the calcium was either inadequate or too sparingly soluble, and that the added calcium and phosphorus contained in both the whole and the skimmed milks ensured an easily assimilable high mineral intake. Other work in this country and abroad has confirmed these findings. Among adolescents, whose skeletal structure is still developing, the same need for added minerals exists in many cases, and it is recognised that adults too, and especially expectant and nursing mothers, will derive substantial benefit from the regular use of milk.

All children should receive a ration of from 1 to 2 pints of milk daily. Under the milk-in-schools scheme, introduced by the Milk Marketing Board, milk for school children is made available at half the usual cost. Expectant and nursing mothers should be supplied with 2 pints of milk daily and adults in general should take not less than ½ pint. Prior to the Second World War the national consumpt of milk in England was given as 0·3 pint per head per day, and that in Scotland as 0·48 pint. The corresponding figure in the State of New York was put at 0·85 pint. In 1943 0·65 pint was quoted for England.

It is essential that all milk should be (1) genuine, (2) clean and (3) safe.

Genuine Milk

The law takes an interest in the genuineness of milk sold, intending that it should be precisely as drawn from the healthy cow. The Public Health (Preservatives, etc., in Food) Regulations, 1925 to 1940, forbid any person to put colouring matter into milk, or to add water to it or any preservative, or to abstract a portion of its fat, or to mix skimmed milk with what is professed to be whole milk. The quantities in which the various constituents of cow's milk are present are subject to a considerable degree of natural variation, the greatest variability being shown by the fat content. With regard to fat and other solids the Sale of Milk Regulations, 1901, presume that a milk is not genuine if it contains less than 3 per cent. of milk fat and less than 8·5 per cent. of solids-not-fat. A genuine skimmed milk should contain not less than 8·7 per cent. total solids. Breaches of the above requirements by vendors constitute adulteration and are subject to penalty on conviction.

Adulteration

Evidence of the adulteration of a sample of milk may be obtained by applying to it the tests for the addition of water or the abstraction of cream, thus

Water Added. If a milk sample is found to contain 7·2 per cent. Solids-not-Fat, the percentage of genuine milk is $\frac{7 \cdot 2}{8 \cdot 5} \times 100 = 84 \cdot 7$ and the percentage of added water is $100 - 84 \cdot 7 = 15 \cdot 3$.

The cryoscopic or freezing-point method may also be employed for the detection of added water in milk. The freezing point of normal milk has been found to vary within narrow limits, lying between —0·530° C. and —0·566° C. Depressions of the freezing point less than —0·530° C. suggest the addition of water. The method, perfected by Hortvet and commonly known as the Hortvet test, requires a standardised cryoscope. The milk samples should be as fresh as possible and should not show acidity above 0·15 per cent. in terms of lactic acid.

Cream Abstracted. If a milk sample is found to contain 2·5 per cent. of fat, since a genuine milk contains 3 per cent. the fat abstracted is $3 - 2{\cdot}5 = \frac{3}{0{\cdot}5}$ per cent. That is, $0{\cdot}5 \times 100 = 16{\cdot}6$ per cent. of abstracted cream.

Clean Milk

Though milk is open to contaminations in transit and in course of delivery the main risks to cleanliness are those of the cow-shed, especially during the process of milking. The faeces of the cow are the chief constituent of the dirt in milk. The cleanest milks contain many bacteria: dirty milks are thronged, and the numbers in all milks, even the cleanest, increase rapidly unless care is taken to keep the temperature down. For the production of a clean milk good construction of premises helps and good management is essential.

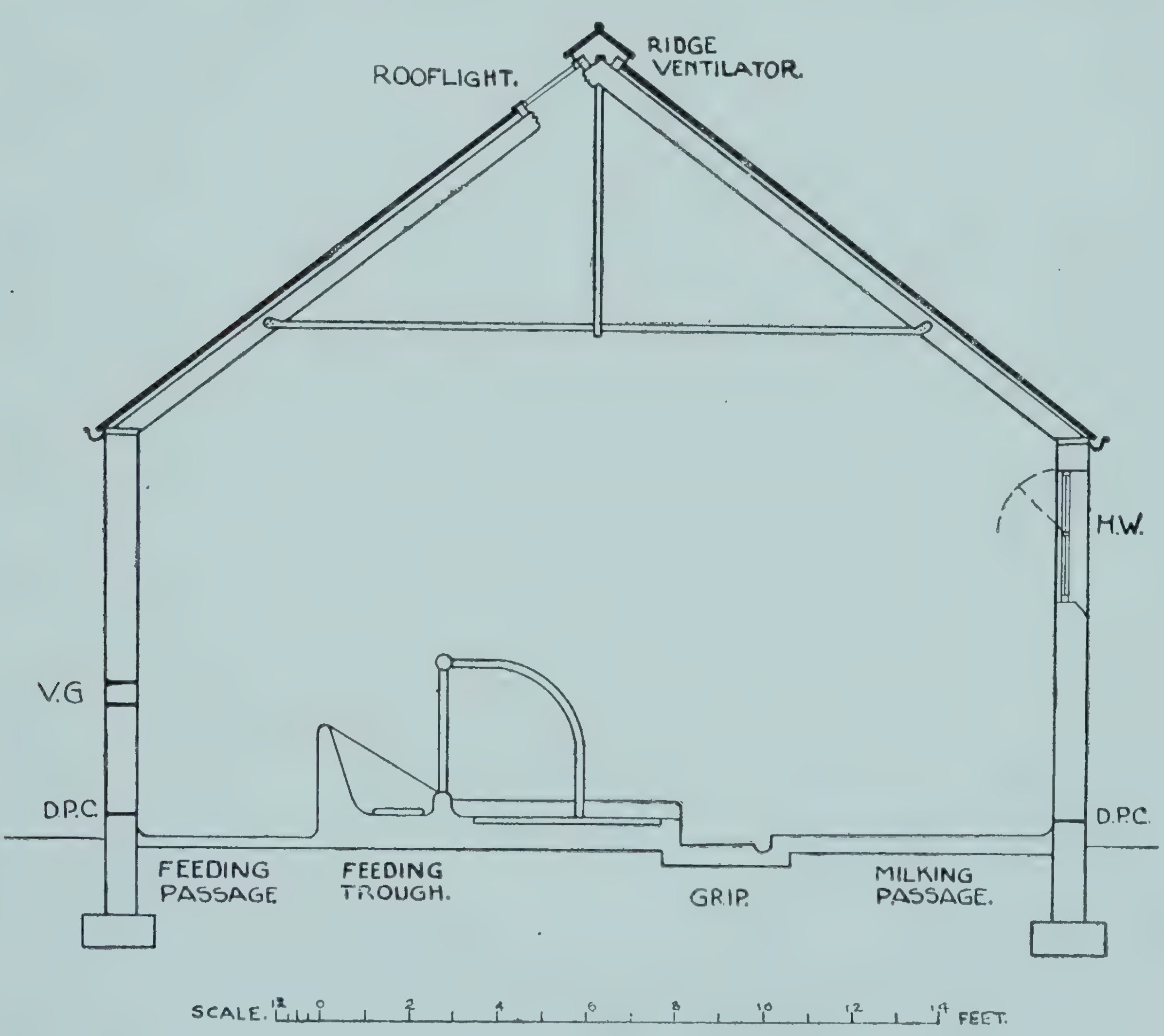

Fig. 50.—Cowshed: Section.

DPC=Damp Proof Course. HW=Hopper Window. VG=Ventilating Grid.

Dairy Construction. A cow-shed (Fig. 50) may be constructed of stone, brick, concrete or other material, with the inner surfaces of stone or brick walls coated with cement plaster to a height of 5 feet or more. The floor should be of concrete, asphalt or granolithic with cork asphalt in front of the mangers. All edges but those of grips or standings should be smoothed away. There should be no loft over the cow-shed: the roof should be open to the ridge, where there should be a ridge ventilator running the whole length of the shed. The air space per cow should be between 400 and 800 cubic feet. Lighting and ventilation should be ample. The stalls should be single with trevisses of smooth impervious material such as cement concrete. Feeding troughs should be of cement concrete and each cow should have an automatic individual drinking bowl. There should be a head feeding passage 4 feet wide. An ample supply of water is indispensable and wherever possible it should be piped in.

Dairy Management. All the cows should be groomed daily with a curry comb and brush, and the long hair of the hind-quarters and udder clipped. Before milking, the udder should be washed and wiped over with a weak disinfectant, and immediately prior to milking the milkers should wash their hands. They should wear clean overalls and milk dry-handed. Milking stools should be well scrubbed. Milking pails should be of the covered or small-top pattern with lateral opening. The first few jets of milk should be directed into a small separate pail and discarded. The milk should be cooled immediately after withdrawal to 55° F. or lower. Over most of the year water suffices for cooling: in hot weather refrigerating plant may be required. The milk should be strained through cloth or cotton wool. All milk utensils should be rinsed with warm water immediately after use: then scrubbed with hot water and soda, washed out with clean hot water and finally sterilised in a steam steriliser or over steam jets or by boiling in a copper. For mechanical milkers special measures require to be adopted, lest thermophilic and other micro-organisms should establish themselves in the enclosed parts of the machines.

Good methods for the production of clean milk are included among the conditions to be observed by holders of licences to sell tuberculin-tested and accredited milks.[1]

Safe Milk

Clean milk cannot however be assumed as a matter of course to be safe to drink. Even measures sufficient to produce in milk a high degree of cleanliness are not necessarily such as to ensure its freedom from pathogenic bacteria. Owing to its composition milk is a favourable medium for the proliferation of micro-organisms. If invaded, as it readily may be, by certain pathogenic strains, it will become infective and so give rise to milk-borne disease. Typically, such an outbreak begins suddenly with the simultaneous sickening of a number of persons all supplied with milk from the same source. More children are usually affected than adults and more females than males. The peak of the outbreak is quickly reached. Then it subsides more slowly, being often prolonged by secondary cases. The outbreak may on occasion attain to formidable dimensions, as at Montreal in 1927.

When the milk-borne disease is an enzootic communicable to man, the infective micro-organism is present in the cow's milk before it is withdrawn from her udder. Measures to render a milk secure against bacteria so originating must be by way of preventing the cow herself from contracting the infection. In other cases, where the disease is one affecting only the human subject, its source is usually to be sought among the milkers at the dairy, who convey the causative organism to the milk with their hands, or by buccal spray, in the act of milking. Action to keep the milk safe under these conditions consists in excluding from the work of the dairy any suspects, carriers where known, contacts, or sick persons until, after medical examination, they receive a clean bill of health.

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[1] Pages 239 and 240.

The preventive measures applied, whether to the cow or the milk handler, necessarily vary with the natural history of the disease concerned, but whatever may be attempted the object in view is to protect the milk against bacterial invasion, that is, to keep it safe.

Even however in cases where the milk has been already invaded, and has therefore ceased to be safe, we are not without resources. By applying heat to the milk in an appropriate manner we can kill off the pathogenic bacteria in it. The process of pasteurisation is a valuable reserve agency in support of the measures for preventing bacterial access. Where the bacteria have already gained access to the milk it is our principal line of defence against milk-borne disease.

Milk is commonly transported by rail in glass-lined cork-insulated tank waggons of some 3000 gallons capacity. The tanks are sterilised by steam. The principal disadvantage of the bulk system is that any infection present cannot readily be traced back to its original source.

Milk and Dairies Orders, 1926-1938

All local authorities are to keep registers of all dairies and dairymen in their district. No person may carry on the trade of dairyman unless he and his premises are registered.

All dairies and buildings for keeping milk must have sufficient windows or other openings communicating with the external air so as to ensure proper lighting and ventilation. Where milking is carried on in the dark, adequate artificial lighting must be maintained.

There must be a satisfactory water supply free of contamination. Receptacles for the storage and conveyance of water must be emptied and cleaned. The supply used for watering cows must be free of foul water.

Milk must be placed where it will not be liable to contamination or infection. It must not be kept in a kitchen, scullery, living room, sleeping room, or in any place communicating with a watercloset, earthcloset, privy, cesspool or receptacle for ashes, or in a room occupied by a case of infectious disease or not disinfected after such occupation, or in any room in which there is an untrapped drain inlet.

Vessels containing milk must be protected from flies and other contamination.

No soiled bed- or body-clothing may be conveyed through any part of a building used for the storage of milk.

All persons engaged in milking or handling milk or milk receptacles must keep clothing, persons and receptacles in a cleanly condition.

No process in connection with milk shall be carried on where there is liability to contamination from manure heaps and the like.

If a case of infectious disease occurs in the household of a person engaged in handling milk he shall at once notify the occupier of the registered premises, who shall immediately inform the medical officer of health of the district.

Should the medical officer of health of any district become aware that any such person is suffering from or has been in contact with infectious disease, he shall notify the occupier of the premises and also the medical officer of health of the registering authority. When a medical officer of health is in possession of evidence that any person is suffering from infectious disease conveyed by milk supplied within the district, he may by notice specifying the evidence stop the sale of milk and milk products. Any such notice is operative for a period not exceeding twenty-four hours, but may be renewed for a similar period or periods. If the infected milk has come from outside his own district then he must notify the medical officer of health concerned.

Any person who suffers damage or loss by reason of such a notice, when it is afterwards proved that no infectious disease was caused by the consumption of such milk, shall be entitled to full compensation.

If a medical officer of health suspects that any person employed on registered premises is suffering from or has recently been in contact with infectious disease he may, after notice to the occupier, make an examination of all or any of the employees, and if necessary prohibit them from milking cows or handling milk in any way.

No person shall keep swine or poultry in any place where milk or milking utensils are kept, or in any place communicating directly therewith.

All milk vessels and appliances must be cleaned and scalded with steam or boiling water, and stored in a clean place. No preservative or oxidising agent may be used for cleaning except in the case of mechanical milkers.

Cowsheds must be kept clean and the interiors lime-washed at least twice every year. Dung must be removed at least once daily.

Milking must be carried out in good light (natural or artificial). Before milking begins, the flanks, udders and teats of each cow must be cleaned. The hands of the milker must be washed and dried, and kept dry as far as possible. Milking stools must be kept clean. Nothing shall be done to cause dust within half an hour of milking.

Immediately after milking, the milk shall be removed and placed in a covered receptacle. As soon as practicable the milk, with some exceptions, must be cooled to a temperature not more than 5° F. higher than that of the cooling-water. On arrival at a collecting station, unless cooled already or intended to be used for the manufacture of milk products, milk shall be cooled to a temperature not exceeding 55° F.

All cowsheds must be so constructed in respect of floors and drainage as to prevent the soiling of the cows, and to convey liquid matters to a suitable drain outside of the building.

All receptacles used in the measurement, storage or delivery of milk shall be such that the interior may be readily cleansed.

Every churn or receptacle, other than bottles, shall be thoroughly cleansed when empty, and securely closed before being returned, and when used for the conveyance of milk by road or rail must comply with the following requirements: name and address of owner to be permanently marked on or securely fixed to the churn or receptacle: lid without openings to be provided: said lid to be dust- and rain-proof. Churns or other receptacles must not be opened in railway vans or stations except for the purpose of checking and sampling milk. All churns and receptacles containing skimmed or separated milk must be plainly marked accordingly in large type.

When milk is delivered in bottles every bottle shall be filled and closed on registered premises and not tampered with before delivery to the consumer. Every person engaged in the conveyance or distribution of milk shall take all practical precautions to prevent the milk from being contaminated or exposed to heat.

The interior of every vehicle used for the conveyance of milk shall be kept clean, and no live animal or any article likely to contaminate the milk shall be conveyed at the same time. If any vehicle has been used for the conveyance of offensive matter it must be thoroughly cleansed before being used to carry milk.

MILK-BORNE DISEASES

Tuberculosis. The tuberculosis of bovines is spread in cow-sheds from one cow to another mainly by the sputum of infected animals. It may be contracted also from contaminated pastures. Though less than 0·5 per cent. of calves are tuberculous at birth, 40 per cent. of dairy cows react to the tuberculin test. The great majority however are in early stages and not yet open cases. Later on, when the udder is invaded, their milk contains live tubercle bacilli of the bovine type. The infection may reach the milk also through contamination with cow faeces containing infective sputum. All sources included, it has been estimated that 1 per cent. of cows in herds are giving tuberculous milk. Six per cent. of samples of raw market milk are charged with tubercle bacilli, and 40 per cent. of carcases of cows slaughtered in public abattoirs show tuberculous lesions.

Bovine tuberculosis in Man is almost exclusively non-pulmonary, affecting the abdomen, bones and joints, lymphatic glands and nervous system, and invading by way of the alimentary tract. Five per cent. of all the tuberculosis deaths in England are due to bovine bacilli : under the age of 15 the proportion is 25 per cent. Most of the deaths occur in the age of childhood, since children drink most milk.

Bang's method of building up a tubercle-free herd consists in removing all calves from their mothers at birth, feeding them first on tubercle-free milk and then grazing them apart. The herd so created is tuberculin tested periodically and reactors transferred out.

Tuberculin-Tested Herds under the Milk (Special Designations) Orders are kept tubercle-free by admitting only non-reactors and discarding all animals which react to the periodical tuberculin tests.

Attested Herds in terms of the Tuberculosis (Attested Herds) Scheme, 1938, are herds freed of tuberculosis by their owners, then tuberculin tested annually at the instance of the Ministry of Agriculture and Fisheries and no reactors found. Their milk is value for a bonus per gallon sold. For milks other than those protected as above pasteurisation is the proper plan.

The Tuberculosis Order of 1938 empowers the notification and slaughter of bovine animals suffering from clinical tuberculosis. For the purposes of the Order, affected animals are classed as (a) suffering from tuberculous induration or other chronic disease of the udder, (b) suffering from tuberculous emaciation and (c) suffering from chronic cough with clinical evidence of tuberculosis. Compensation is paid for all animals slaughtered under the Order. Under the Food and Drugs Act, 1938, it is an offence to sell the milk of a cow suffering from tuberculosis or giving tuberculous milk. A good practice is the routine inspection of dairy herds by veterinary inspectors.

With a view to the protection of cow's milk against inoculation with tubercle bacilli of human origin the Public Health (Prevention of Tuberculosis) Regulations, 1925, provide for England and Wales that a person suffering from respiratory tuberculosis may, if employed about a dairy, be required to desist from the work.

Typhoid Fever. Milk readily conveys typhoid fever. In Massachusetts lately over a period of 17 years the cases of milk-borne typhoid were four times as numerous as the water-borne cases. Infection may ensue upon contact of the milk with the hands of ambulant cases or carriers. It may be derived from contaminated water used for washing milk vessels. One milk-borne outbreak with which one of us had to deal resulted from washing the bed linen of a sick person along with milk utensils. In the milk-borne typhoid at Montreal in 1927 there were 5002 cases and 533 deaths. Three-fourths of the sick had been consumers of the output of one dairy company, and the evidence pointed to infection of the milk at farm sources. Milk richly inoculated with *B. typhosus* may present a perfectly normal appearance.

Paratyphoid Fever also may be spread by milk. In the outbreak at Odense in Fünen Island in 1928 the infection was traced to a stable boy at the farm. Of 342 persons who drank of the milk 201 took paratyphoid fever.

Scarlet Fever. Milk-borne scarlet fever is not uncommon. The streptococcus, which is of human origin, gains access to the milk, during or after milking, from a missed or concealed case. A feature of some recent outbreaks has been a concomitant train of cases, in our own experience mostly adults, suffering from sore throat without rash. In the large milk-borne outbreak at Chelmsford the sore throats without rash were 4 to 1 of the cases which showed the exanthem.

Septic Sore Throat among milk consumers may ensue upon a septic mastitis of the cow. As a rule however the udder is normal and the infection is ascribed to invasion of the milk in the ampullae of the udder by a streptococcus of human origin which is non-pathogenic to cattle. In the outbreak at Lee in Massachusetts in 1928 the peccant cow had septic mastitis. Of the 4000 people in the town 950 were stricken and 48 died.

Diphtheria as a milk-borne disease is comparatively rare. The infection proceeds from a human source such as an unrecognised case or carrier. It has been suggested however that sores on the teats of the cow may harbour the diphtheria bacillus and so infect the milk.

Other diseases which may be conveyed by milk are epidemic enteritis, bacillary dysentery and cholera, which are of human origin, and the enzootics undulant fever and foot and mouth disease. Brucella abortus, the causative agent of one of the varieties of undulant fever, is not infrequently recovered from milk samples in this country.

Milk-borne infections in general, as already noted, can be prevented by pasteurising the milk.

DESIGNATED MILKS

The procedure with reference to these milks is laid down in the Milk (Special Designations) Orders and Provisional Regulations, 1936 to 1946. The designations which may be authorised by licence for milk in England and Wales are Tuberculin Tested, Accredited, Pasteurised and Heat Treated. The purpose of the Order is to stimulate and safeguard the production of clean and safe milks. Tuberculin-tested milk is intended to be safe in respect of tuberculosis and also clean. Accredited milk is intended to be clean. Properly pasteurised milk is safe in respect of the infections commonly conveyed by milk. County and County Borough Councils grant the licences for tuberculin-tested and accredited milks: other licences may be granted by the Councils of County and Municipal Boroughs and Urban and Rural Districts. Designated milks are required to be kept separate from other milks, and the licensing authority before granting a licence must satisfy itself as to the sufficiency of the arrangements made by the applicant to produce the kind of milk to be specified in his licence.

Tuberculin-Tested Milk. *Herd.* Every animal must be clinically examined by a veterinary surgeon every 6 months or oftener. Every animal must be tuberculin tested every 6 months or oftener but not within 2 months of the last preceding test. No animal may be introduced into the herd unless it has within 14 days been tuberculin-tested and found tubercle-free, or unless it is a non-reactor from an attested or tuberculin-tested herd. Where the herd is itself an attested herd the rules for attested herds apply. All reactors must be removed from the tuberculin-tested herd. Animals showing evidence of disease likely to injure the milk must be segregated or removed and the facts placed on record. Milk from segregated cows must not be called tuberculin-tested. The herd must be completely isolated from all other cattle, and every animal in it must bear an identification mark and be entered in a register. *Handling.* The milk must be consigned from the farm either in bottles or sealed containers, and delivered by dealers to consumers either as received or in bottles, or containers holding not less than 2 gallons. A bottle may hold up to a quart but not more, and approved containers such as cartons may be used instead of bottles. All bottles must be tightly closed and labelled 'tuberculin-tested milk.' No heat may be applied to the milk at any stage unless for pasteurisation, in which case the milk is required to be labelled 'tuberculin-tested milk (pasteurised).' Where the milk has been bottled at the farm it is permitted to label it 'tuberculin-tested milk (certified).' *Tests.* Tuberculin-tested milk at any time before delivery must not reveal the presence of coliform bacilli in $\frac{1}{100}$ ml., and in the reductase test must not decolorise methylene blue from 1st May to 31st October in 4½ hours and from 1st November to 30th April in 5½ hours. If the milk has been pasteurised it must not contain more than 30,000 bacteria per millilitre.

Accredited Milk. *Herd.* Every milch cow must be examined once in 3 months by a veterinary surgeon. Cows showing evidence of disease likely to injure the milk must be segregated or removed from the herd and the facts placed on record. Milk from segregated cows must not be called accredited. No known reactor to tuberculin may be added to the herd. Cows in milk belonging to the herd must be kept separate from other cows in milk, and all milch cows must bear an identification mark and be entered in a register. *Handling* is the same as for tuberculin-tested milk, except that the label reads 'accredited milk,' and that, where applicable, the expression 'farm bottled' takes the place of 'certified.' *Tests.* The tests are the same as for tuberculin-tested milk.

Pasteurised Milk. *Herd.* No conditions are laid down for the herd. *Handling.* The milk must be retained at a temperature of not less than 145° and not more than 150° F. for at least half an hour, or, using the 'High Temperature Short Time' method, at a temperature of not less

DESIGNATED MILKS

Table 27. England and Wales

Tuberculin Tested.	Accredited.	Pasteurised.
	HERD.	
Introduce only non-reactors, after recent tuberculin test. Submit all animals periodically to (1) tuberculin test removing all reactors, and (2) examination by Veterinary Surgeon. Remove or segregate all sick animals likely to injure milk. Keep herd isolated from other cattle. Every animal to be marked and entered in a register.	Introduce no known tuberculin test reactor. Submit all milch cows periodically to examination by Veterinary Surgeon. Remove or segregate all sick animals likely to injure milk. Keep cows in milk separate from other cows in milk. Every milch cow to be marked and entered in a register.	No conditions.
	HANDLING.	
Consign milk in bottles or sealed containers. Label 'Tuberculin Tested Milk.' If pasteurised, add '(pasteurised.)' If bottled at farm, add '(certified.)' Unless for pasteurisation, apply no heat.	Consign milk in bottles or sealed containers. Label 'Accredited Milk.' If pasteurised, add '(pasteurised.)' If bottled at farm add '(farm bottled.)' Unless for pasteurisation, apply no heat.	Pasteurise at temperature not less than 145° F., and not more than 150° F., for half an hour (or at temperature not less than 162° F. for at least 15 seconds) and then immediately cool to 55° F. Treat once only, and apply no other heat. Hold and transport milk in special containers labelled 'Pasteurised Milk.'
	TESTS.	
Coliform bacteria absent from $\frac{1}{100}$ ml. Colour of methylene blue not discharged in 4½ hours in summer and 5½ in winter. *If pasteurised, not more than 30,000 bacteria per ml.*	Coliform bacteria absent from $\frac{1}{100}$ ml. Colour of methylene blue not discharged in 4½ hours in summer and 5½ in winter.	Phosphatase Test, Methylene Blue Test.

DESIGNATED MILKS

TABLE 28. SCOTLAND

Certified.	Tuberculin Tested.	Standard.	Pasteurised.
HERD.			
Introduce only non-reactors, after recent tuberculin test.	Introduce only non-reactors, after recent tuberculin test.	Introduce no known tuberculin test reactor.	No conditions.
Submit all animals periodically to (1) tuberculin test, removing all reactors, and (2) examination by Veterinary Surgeon.	Submit all animals periodically to (1) tuberculin test, removing all reactors, and (2) examination by Veterinary Surgeon.	Submit all milch cows periodically to examination by Veterinary Surgeon.	
Remove or segregate all sick animals likely to injure milk.	Remove or segregate all sick animals likely to injure milk.	Remove or segregate all sick animals likely to injure milk.	
Keep herd isolated from other cattle.	Keep herd isolated from other cattle.	Keep cows in milk separate from other cows in milk.	
Every animal to be marked and entered in a register.	Every animal to be marked and entered in a register.	Every milch cow to be marked and entered in a register.	
HANDLING.			
All milk to be farm bottled.	Consign milk in bottles or sealed containers.	Consign milk in bottles or sealed containers.	Pasteurise at temperature not less than 145° F. and not more than 150° F. for half an hour (or at temperature not less than 162° F. for at least 15 seconds) and then immediately cool to 50° F.
All milk to be cooled to 50° F. Apply no heat.	All milk to be cooled to 60° F. Apply no heat.	No heat to be applied.	
All containers to be steam sterilised.	All containers to be steam sterilised.	All containers to be steam sterilised.	
Label 'Certified Milk.'	Label 'Tuberculin Tested Milk.' If pasteurised add '(pasteurised.)'.	Label 'Standard Milk.'	Treat once only and apply no other heat. Hold and transport in special containers labelled 'Pasteurised Milk.'
TESTS.			
Not more than 30,000 bacteria per ml.	Not more than 200,000 bacteria per ml.	Not more than 200,000 bacteria per ml.	Phosphatase test.
Coliform bacteria absent from $\frac{1}{10}$ ml.	Coliform bacteria absent from $\frac{1}{100}$ ml.	Coliform bacteria absent from $\frac{1}{100}$ ml.	Coliform bacteria absent from $\frac{1}{100}$ ml.
	If pasteurised not more than 30,000 bacteria per ml.		In specified areas methylene blue test.
	Coliform bacteria absent from $\frac{1}{10}$ ml.		

than 162° F. for at least 15 seconds, and then immediately cooled to not more than 55° F. The milk may be so heated once only and must not be otherwise subjected to heating. An indicating thermometer and a recording thermometer must be fitted to the pasteurising apparatus, temperature records being made and preserved for at least a month. Pasteurised milk may not be put into vessels used for other milk, and every container in which it is transported or held for sale must be labelled 'pasteurised milk.' *Tests.* The milk before delivery must give a phosphatase test reading of not more than 2·3 Lovibond blue units and fail to decolorise methylene blue in 30 minutes.

Heat Treated Milk. Neither herd nor handling conditions are laid down for heat treated milk. The temperature reached by the milk may not exceed 173° F. *Tests.* The tests are the same as for Pasteurised Milk.

Scotland. The Milk (Special Designations) Order (Scotland), 1936, and amending Orders lay down the procedure for designated milks in Scotland. The Scottish designations, five in number, are Certified, Tuberculin Tested, Standard, Pasteurised and Heat Treated. The conditions to be observed are on the same plan as for England but differ in details as noted hereunder:

Certified Milk. All milk to be cooled to 50° F. and bottled at the farm. Tests are these: not more than 30,000 bacteria per millilitre: no coliform organisms in $\frac{1}{10}$ ml. Otherwise=Tuberculin Tested below.

Tuberculin Tested Milk. Clinical examination thrice yearly. Milk to be cooled to 60° F. Bottles and containers to be steam sterilised. Tests are these: not more than 200,000 bacteria per millilitre: no coliform organisms in $\frac{1}{100}$ ml. Otherwise=English Tuberculin Tested.

Standard Milk. Clinical examination thrice yearly. Bottles and containers to be steam sterilised. Tests as in Tuberculin Tested above. Otherwise = English Accredited.

Pasteurised Milk. Milk after pasteurisation to be cooled to 50° F., not 55° F. Temperature records to be preserved for three months, not one. Test: phosphatase test: no coliform organisms in $\frac{1}{100}$ ml.

Heat Treated Milk. This Designation, authorised by the Milk (Special Designations) Amendment Order (Scotland), 1944, is intended to make possible the licencing of a greater number of milk plants. Various types of plant are permitted, subject to certain requirements of local authorities.

Heat Treated Milk may be raised to a temperature not exceeding 173° F. Test: the phosphatase[1] and methylene blue tests are to be employed instead of a bacterial count.

In certain 'specified areas,' Pasteurised Milk is subject also to the Methylene Blue Test in terms of the Heat Treatment of Milk (Prescribed Tests) Order (Scotland), 1944. The position regarding tests may be summarised thus:—

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[1] Page 245.

DESIGNATION OF MILK	TESTS	
	Specified Areas	Non-specified Areas
Pasteurised	Phosphatase Coliform Methylene Blue	Phosphatase Coliform
Heat Treated	Phosphatase Methylene Blue	Phosphatase Methylene Blue

The Scottish Milk Testing Scheme introduced in 1946 by the Department of Health has for its object the detection and elimination of milk of unsatisfactory keeping quality, and the raising of the general standard of milk supplies. Both the incoming and outgoing milks are tested at distributors' premises by the methylene blue and resazurin tests.

In Scotland all licences are granted by County Councils and the Councils of Large Burghs.

The requirements prescribed for designated milks are summarised in Tables 27 and 28.

Tuberculin Test

In the original double intradermal tuberculin test an area of skin about 2 inches square on the side of the animal's neck was shaved or, after clipping, swabbed with S.V.M. A fold of skin in the shaved or clipped area was picked up between the thumb and forefinger and its thickness in millimetres measured with callipers. Undiluted Old Tuberculin (O.T.) 0·1 ml. was then injected, by means of an all-glass syringe with steel dental-pattern needle, passed obliquely into the fold of skin so that the point of the needle was in the deepest layers of the derma.

Forty-eight hours later the site of injection was examined. If a diffuse swelling was found, hot to the touch and tender, with the thickness of the fold measuring thrice the original figure, the animal was held to be tuberculous and no further test administered. If the swelling and the increase of the skin-fold were less marked, opinion was suspended and a second test was given.

The second injection, given 48 hours after the first, consisted as before of 0·1 ml. of undiluted O.T. The point of the needle was due to pass in to about the centre of the infiltration. Twenty-four hours after the second injection the site was again examined. In tuberculous animals palpation revealed that the swelling had now soft irregular edges, and was hot and tender, and the measurement of the fold showed a considerable increase.

In the present-day 'comparative' tuberculin test the procedure and course of events are broadly as narrated above, with certain differences. The inoculum is no longer O.T. but Purified Protein Derivative, lettered

P.P.D. Further, not one but two skin surfaces are prepared on the side of the animal's neck. Into one of these is injected P.P.D. (mammalian) 0·1 ml., and into the other the same dose of P.P.D. (avian). The purpose is to eliminate the disturbing effects of an avian infection. An increase in the thickness of the skin fold of 5 mm. or over is held to be decisive. An animal which responds to the avian P.P.D. only is classed as a 'non-specific reactor' and allowed to remain in the herd.

Pasteurisation

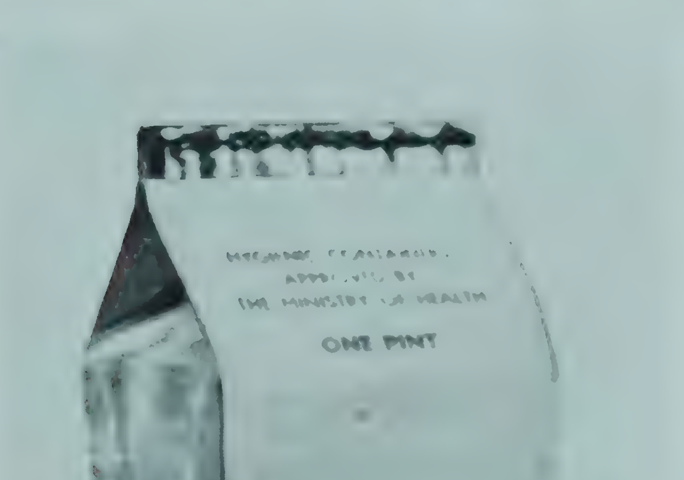

Fig. 51.—Milk Carton.

Pasteurisation, as originally prescribed in the Milk (Special Designations) Order, is conducted by the 'Holder' method, the milk being 'held' thermostatically between 145° and 150° F. for half an hour and then rapidly cooled. Now the 'high temperature short time' method, H.T.S.T., is permitted as an alternative. With H.T.S.T. the milk is exposed to a temperature of not less than 162° F. for 15 seconds. On the stassanisation plan the milk, disposed in thin layers, is heated in a special tube. The 'Electropure' plant employs electricity to heat the milk in the H.T.S.T. process. Exemplary cleanliness is requisite at all stages, particularly in connection with the bottle-washing plant and filling machines. Some recent installations are made to operate *in vacuo*. Cartons (Fig. 51), if used, should be made up on the premises daily from waxed sheet cardboard. If properly waxed they are germ-free. Cartons are closed by crimping. The caps for closing glass bottles should be cut on the premises from sheet aluminium. Laboratory tests bear out the claim that pasteurisation by either the Holder method or H.T.S.T. can be relied upon to kill the ordinary pathogens in milk with a wide margin of safety. In the case of *B. tuberculosis* the margin for the Holder method is ample. For H.T.S.T. the position is that the H.T.S.T. temperature-time combination is 162° F. for 15 seconds, while the demonstrated lethal temperature-time combination for *B. tuberculosis* is 160° F. for 12 seconds. The margin may be described as narrow but presumably sufficient. Experience on the large scale also strongly favours pasteurisation. In London lately, of forty-three tanked raw milks examined, every one was found to contain tubercle bacilli: after pasteurisation every one was free. Of the same raw milks twenty-seven contained *Br. abortus:* all the twenty-seven were freed of the organism by pasteurisation. In Toronto, where 99·8 per cent. of the milk used in the city is pasteurised, 300 children were examined for evidences of bovine tuberculosis: 45, all from outside the city, were found to be suffering from the disease: the remaining 255 were free, being Toronto bred. In the larger cities of the United States, where over 90 per cent. of the milk is pasteurised, milk-borne diseases of any kind are claimed to have practically disappeared.

The enzyme Phosphatase, which occurs in milk, is destroyed by effective pasteurisation. In the phosphatase test applied to pasteurised milk the enzyme, if present, liberates phenol from di-sodium phenyl phosphate, and the phenol combining with Folin's special reagent develops a blue colour which is expressed in terms of Lovibond Units. A properly pasteurised sample yields a reading of 2·3 or less L.U. The figures for imperfect pasteurisation may be as high as 6 L.U., in which case the milk shows up blue. It is claimed that quantities of raw milk so small as 0·25 per cent. of a pasteurised bulk can be detected by the test, which is applicable both to the Holder and H.T.S.T. methods.

Pasteurisation does not denaturise milk to the extent that boiling does. It produces only a slight diminution in the cream line: it coagulates some 5 per cent. of the albumen and produces a 5 per cent. alteration in the Ca : P equilibrium. The vitamin B content of the milk is reduced by 10 per cent., and the vitamin C content by 20 per cent. The fate of vitamin D is uncertain. There is no evidence that these changes have any nutritional significance for children, adolescents or adults who are consuming milk as an addition to a mixed diet. Corry Mann's group of boys,[1] for example, made the progress which they did on pasteurised milk. In feeding pasteurised milk to infants, however, any diminution of vitamins C and D should be compensated by giving orange juice and cod liver oil or their equivalents, which in most cases would be done regardless of pasteurisation, since milk in general is an uncertain source of these vitamins.

MILK DERIVATIVES

Skimmed Milk is milk from which the cream has been skimmed off by hand. It usually contains about 1 per cent. of milk fat. It should contain not less than 8·7 per cent. of total milk solids.

Machine-Skimmed Milk is milk from which the cream has been removed in a centrifugal machine. It is known also as 'separated milk.' It contains less fat than hand-skimmed milk but is required to contain the same amount of total milk solids. The nutritive value of milk from which the fat has been removed has been pointed out above.

Condensed Milk means full cream milk, or skimmed or machine-skimmed milk, which has been concentrated by the removal of part of its water. The milk is heated at 80° C., cane sugar where desired is added, and the mixture is boiled at 50° C. in vacuum pans. When reduced to 33 per cent. of its original volume, it is cooled in rotary coolers and filled into tins. Each tin must bear a label declaring the equivalent value of its contents expressed as pints of full cream milk or skimmed milk, as the case may be. The Public Health (Condensed Milk) Regulations, 1923 and 1927, and the Public Health (Condensed Milk) Regulations (Scotland), 1923, prescribe (i) minimum percentages of constituents as under for raw milks classified by cream content, and the condensed milks prepared from them, including imported condensed milk and condensed milk intended for export if put up in tins of 5 lbs. weight gross or less, and (ii) labels for condensed milks.

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[1] Page 231.

(i) *Minimum Percentages*

	Raw Milk.		Condensed Milk.	
	Milk Fat	Total Solids.	Milk Fat.	Total Solids.
1. Full cream milk, unsweetened . . .	3·6	12·4	9·0	31·0
2. Full cream milk, sweetened . . .	3·6	12·4	9·0	31·0
3. Machine-skimmed milk, unsweetened .	S.N.F.9 Per Cent.		...	20·0
4. Machine-skimmed milk, sweetened . .	S.N.F.9 ,,		...	26·0

(ii) *Labels for Condensed Milk*

1. 'Condensed Full Cream Milk Unsweetened. This tin contains the equivalent of (*a*) pints of milk.'
2. As in 1, but with 'Sweetened' for 'Unsweetened,' and the addition of the words 'with sugar added.'
3. 'Condensed Machine-skimmed Milk [or Condensed Skimmed Milk] Unsweetened. Unfit for Babies. This tin contains the equivalent of (*a*) pints of skimmed milk.'
4. As in 3, but with 'Sweetened' for 'Unsweetened,' and the addition of the words 'with sugar added.'

At (*a*) insert number in words and figures, e.g. 'one-and-a-half (1½),' any fraction being expressed as eighths, quarters or a half. 'Unfit for Babies,' by P.H. (Condensed Milk) Amendment Regulations (Scotland), 1927, and P.H. (Condensed Milk) Amendment Regulations, 1927, for England and Wales, is to be in large type and enclosed in a panel.

Imported condensed milk must comply with the regulations unless imported for re-export, or contained in tins of gross weight over 5 lbs. The Officers of Customs enforce the provisions with regard to imported condensed milk.

Evaporated Milk is milk reduced by evaporation to 50 per cent. of its original volume.

Dried Milk means whole milk or wholly or partially skimmed or machine-skimmed milk, which has been concentrated to a powder or solid by the removal of its water. It has the following average percentage composition :—

Protein	25-28
Fat	25-28
Carbohydrate	34-40
Ash	6-7
Water	5-7

The method of preparation is either (1) to spray the milk on steam-heated metal cylinders from the surface of which the flake formed is scraped off, pounded and packed, or (2) to spray the heated and vacuum-concentrated milk under pressure into a hot-air chamber in which the fine particles immediately dry and, falling to the floor, are collected. It is thought that vitamin C is impaired in the process. All dried milks must be labelled to show their equivalent value as pints of milk. The Public Health (Dried Milk) Regulations, 1923 and 1927, and the Public Health (Dried Milk) Regulations (Scotland), 1923, prescribe (i) minimum percentages of constituents as under for raw milks classified by cream content, and the dried milks prepared from them where put up in tins of 10 lbs. weight gross or less, and (ii) labels for dried milks.

(i) *Minimum Percentages*

	Raw Milk.		Dried Milk.
	Milk Fat.	Total Solids.	Milk Fat.
1. Full cream milk	3·6	12·4	26
2. Three-quarter cream milk . .	2·7	11·6	20
3. Half cream milk	1·8	10·8	14
4. Quarter cream milk . . .	0·9	9·9	8
5. Skimmed milk	S.N.F. 9 per cent.		...

(ii) *Labels for Dried Milks*

1. ‘ Dried Full Cream Milk. This tin contains the equivalent of (*a*) pints of milk.’

At (*a*) insert number in words and figures, e.g. ‘ one-and-a-half (1½),’ any fraction being expressed as eighths, quarters or a half.

2, 3 and 4. ‘ Dried Partly Skimmed Milk ((*b*) Cream). Should not be used for Babies except under medical advice. This tin contains the equivalent of (*a*) pints of (*b*) cream milk.’ At (*a*) insert number as above. At (*b*) insert ‘ three-quarter,’ ‘ half ’ or ‘ quarter ’ as the case may be.

5. Dried Machine-Skimmed Milk [or, Dried Skimmed Milk]. Unfit for Babies. This tin contains the equivalent of (*a*) pints of skimmed milk.’

At (*a*) insert number as above. ‘ Unfit for Babies ’ by the P.H. (Dried Milk) Amendment Regulations (Scotland), 1927, and P.H. (Dried Milk) Amendment Regulations, 1927, for England and Wales, is to be in large type and enclosed in a panel.

Homogenised Milk has a uniform consistence. Its fat does not separate out, the globules having been comminuted by being driven at pressure up to 3000 lbs. per square inch through a slit and allowed to impinge upon the surface of an agate plate.

Sterilised Milk is prepared by a modified flash pasteurisation method, the process being carried out in special long-necked bottles, which are immediately thereafter cooled and automatically sealed with metal caps.

Cream consists of the fat of milk together with protein and lactose. As the bacteria in milk rise with the cream, the bacterial count of cream is relatively high. An inferior cream may contain 25 per cent. of milk fat: a good cream 45 per cent. or over. Devonshire cream, which is prepared by heating milk in deep pans, contains 55 to 60 per cent. of fat. Given adequate cold storage cream keeps sufficiently well. In any case it is illegal to add a preservative to it.

Artificial Cream in terms of the Food and Drugs Act, 1938, and in Scotland the Artificial Cream Act, 1929, is an article of food resembling cream and containing no ingredient which is not derived from milk, except water or any ingredient which may lawfully be contained in cream. It is made from an admixture of water, dried milk and fresh butter, with subsequent treatment in an emulsifier. It is favoured by bakers and confectioners, as well as for domestic use, on account of its better keeping qualities as compared with ordinary cream. A preparation which resembles cream but includes in its composition fat other than milk or butter fat is not artificial cream in terms of the Act. It may be referred to as 'confectionery filling.' It is believed to have produced a sharp outbreak of paratyphoid fever in Dundee, in which there were 331 confirmed cases and 5 deaths.

Ice Cream generally contains milk powder, butter, granulated sugar and gelatine, together with water and a flavouring agent. The mixed ingredients are placed in an emulsifier, heated to 145° F. then cooled to 45° F. and finally frozen. Ice cream has been the vehicle of infection in typhoid fever, dysentery and bacterial food poisoning. In a recent Scottish outbreak of scarlet fever involving upwards of eighty cases, one of us recovered the haemolytic streptococcus responsible from ice cream served by a faucial carrier of that strain. The question of chemical and bacteriological standards for ice cream is now engaging the attention of the authorities.

Butter is prepared from milk or cream by the process of churning, as a result of which the ruptured milk-fat globules collect together into a granular mass. If the stage of granulation is not reached, the butter readily sours. Legally, butter must be made exclusively from milk or cream or both. Its percentage composition approximates to the following:—

Fat	84
Casein	1
Salt, etc.	2
Water	13
	100

It may not contain more than 16 per cent. of water. Salt and colouring matter may be added to it, but no chemical preservative. Butter, like cream, has a relatively high bacterial count. If prepared from tuberculosis milk it may be found charged with tubercle bacilli. As it contains the milk fats it is a recognised seasonal source of vitamins A and D. Australian and New Zealand butters are claimed to possess a high and uniform initial content of these two vitamins, which show stability in cold storage during the voyage to this country. Butter-milk, the by-product of butter-making, has a considerable nutritive value. It includes most of the lactose and much of the casein of the original milk.

Milk-Blended Butter is the name given to butter which has been worked up with milk or cream other than condensed milk or cream. It may not contain more than 24 per cent. of water.

Margarine is defined in the Food and Drugs Act, 1938, and in Scotland in the Food and Drugs (Adulteration) Act, 1928, as 'any article of food, whether mixed with butter or not, which resembles butter and is not milk-blended butter.' Originally prepared from animal fats, margarine is now largely of vegetable origin, being derived from cocoa-nut, cotton-seed, palm kernel and similar oils. Vegetable margarines are lacking in vitamins A and D, but the fat-soluble vitamins, extracted from marine livers and dissolved in an edible oil, may be incorporated in them. Brands of margarine so treated may possess a vitamin potency above that of native butter, especially in winter. The legal limit for water in margarine is 16 per cent. The addition to margarine of more than 10 per cent. of butter fat constitutes an adulteration. In the sale of margarine the law requires every wholesale package to be branded or marked 'margarine,' every parcel exposed for retail sale to be labelled 'margarine,' and every quantity sold otherwise than in the original parcel to be put up in a wrapper lettered 'margarine' in capital block letters not less than ½ inch long.

Cheese. Consisting of the casein and fat of milk, cheese is a tissue builder and source of energy. There are no quantitative legal standards for cheese. Its nitrogenous matter may range from 18 to 35 per cent.: its fat from 10 to 45 per cent.: its water from 20 per cent. upwards. Hard cheeses are Cheddar, Cheshire, Dunlop, Edam, Gruyère, Parmesan, Roquefort and American. Soft cheeses are Brie, Camembert, Gorgonzola, Limburg, Stilton, Cream and Lactic. Most cheeses emanate from cow's milk, but Parmesan is made from goat's milk and Roquefort from ewe's. Cheese proper should contain no fat other than milk fat. Margarine cheese is a substance prepared in imitation of cheese, which contains fat not derived from milk. Cheese which is wrapped in lead or tin foil may contain in its superficial layers metallic impurities derived from the foil. Specimens of cheese presenting fungoid growths are the most likely to have become contaminated by metal from the foil wrapping.

Pasteurisation of the milk for butter churning and cheese making is prophylactic of tuberculosis.

MEAT

Meat consists of muscle-protein, fat and connective tissue. The proportion of protein in beef is about 14 per cent., in mutton about 12 per cent. and in pork 12 to 14 per cent. Good meat is dry, firm and elastic, and red in colour unless naturally white. The fat is firm and white or pale yellow, the lymphatic glands firm and yellowish grey. The odour is agreeable. Meat which is hung becomes tender as rigor mortis passes off with resolution of the coagulated myosin. Frozen meat, after defrosting, is darker and moister than fresh meat and the fat is stained by the meat juices. In chilled meat the fat may be pinkish.

The healthy meat animal should present supple skin, a well-conditioned coat and firm, elastic flesh. The eye should be bright and the nostril pink and moist. Breathing should be easy and regular and halitosis absent. Trembling, inability to rise easily and lolling tongue are indicative of poor condition. The teats of cows should be cool to the touch.

Slaughter

Meat with blood left in it does not keep well. It is therefore desirable that meat animals should be killed in such a way that their tissues will be rapidly drained of blood. At the same time every precaution should be taken to spare them all needless suffering. Both these requirements are met by first stunning the animal and then quickly cutting across the great vessels at the root of the neck. Death ensues from the copious haemorrhage before consciousness can return.

Quite recently the most approved weapon was the captive bolt pistol (Fig. 52), the bolt of which, after penetrating the brain, returned automatically to the barrel. Now the pistol is being superseded locally by the electrical stunner (Fig. 53), except for adult bovines. This instrument is fitted with a couple of electrodes, kept moist with water or salt solution, which are applied to the animal's head. When the charge of 70 to 90 volts is freed, the animal falls and remains unconscious for 4 to 6 minutes, which gives the slaughterman ample time to induce the fatal bleeding. It is claimed that with electrical stunning the animal is more completely bled, since the heart continues to beat longer than with methods which involve gross disruption of the brain tissue.

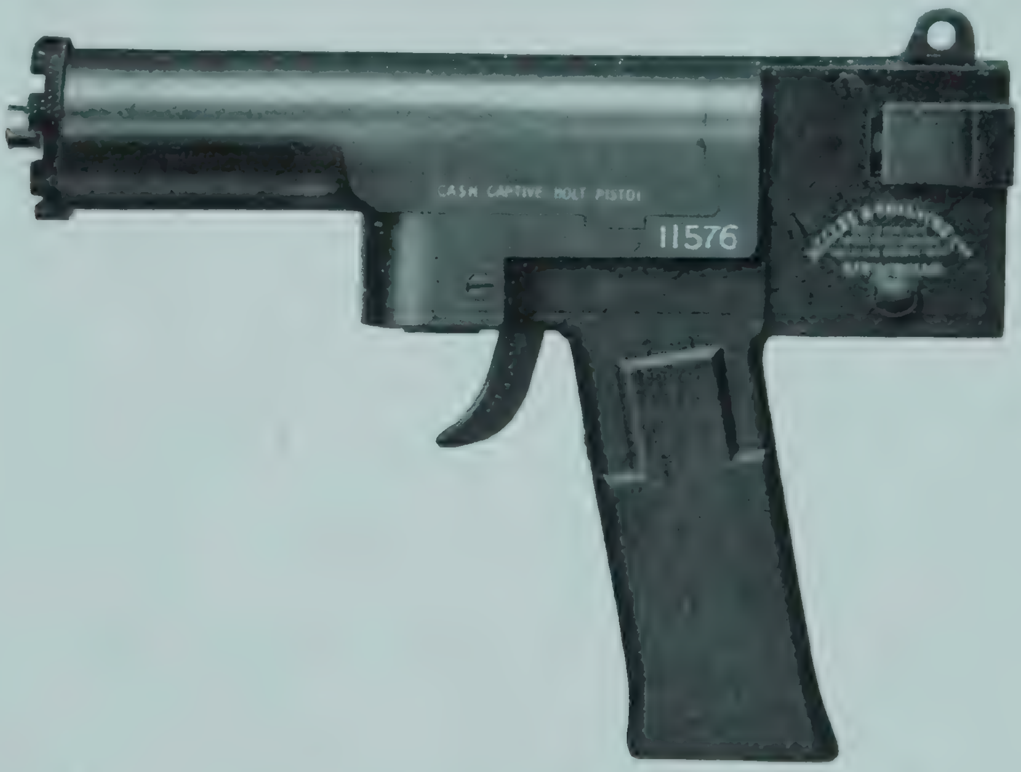

Fig. 52.—Captive Bolt Pistol.

By the Slaughter of Animals Act, 1933, slaughter in slaughter houses or knackers' yards in England must be instantaneous, or the animal must by stunning be rendered insensible to pain until death supervenes. A mechanically operated instrument, which is held to include an electrical instrument, must be used. Pigs come under the protection of the Act only in places where a supply of electrical energy is available, and sheep only where the local authority resolves to include them. Goats may, if the local authority so resolves, be denied the protection of the Act.

Horses, asses, mules and oxen are unconditionally included. All slaughtermen must be licensed. All animals awaiting slaughter must be supplied with water and after 24 hours with food also. Blood or refuse of slaughter must not be allowed to flow within sight or smell of any animal in a slaughter house or knacker's yard. The provision as to stunning does not apply to Jewish ritual slaughter or to slaughter by a Mohammedan for the food of Mohammedans.

In Scotland the corresponding Act is the Slaughter of Animals (Scotland) Act, 1928. It is substantially to the same purpose as the English Act except that electrical stunning is not specifically mentioned, and that horses, asses, mules, oxen, sheep and goats all come under the protection of the Act, pigs being excluded.

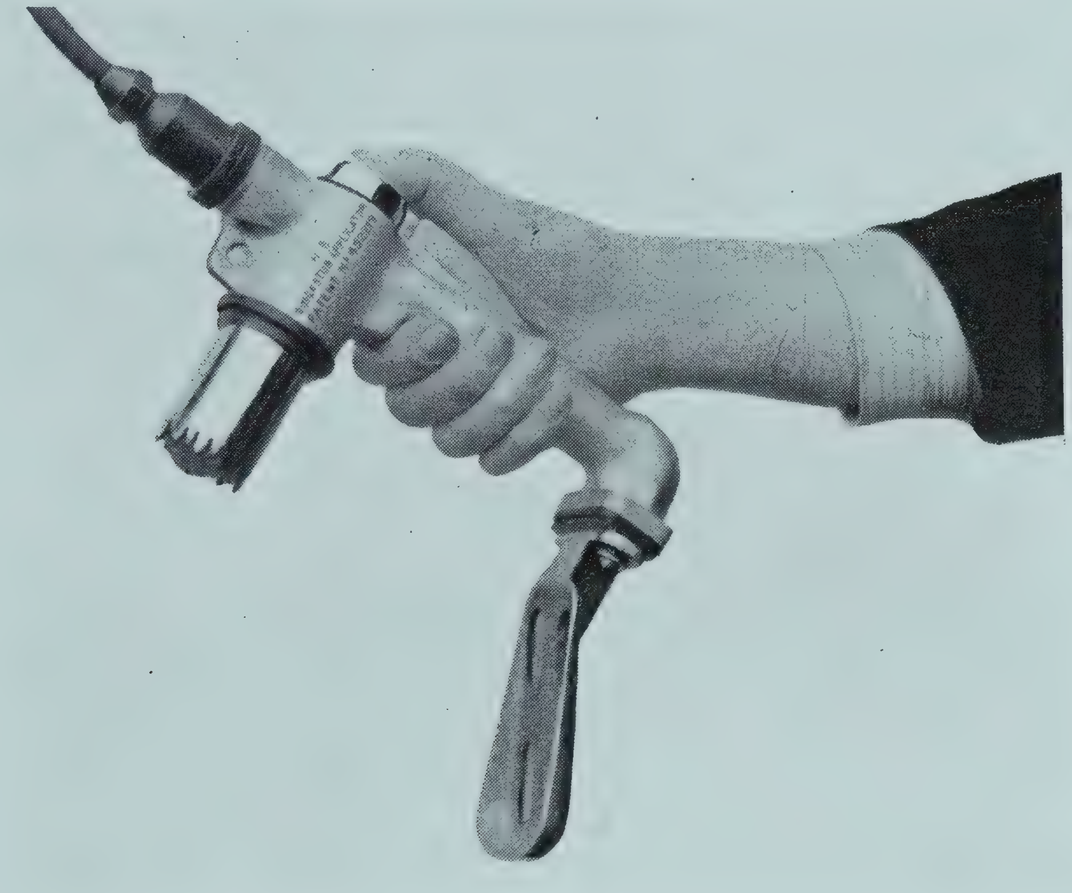

Fig. 53.—North British ‘ Quickstun ’ Applicator.
For Sheep and Calves.

The hollowed-out lower electrode receives the muzzle of the animal, which supplies the necessary moisture. The cylindrical upper electrode, which contains a sponge wet with water or salt solution, is let down on the animal's brow. The current is then switched on by means of the water-proofed control on which the thumb of the operator is resting.

In the Jewish ritual slaughter animals are bled to death without previous stunning. In order to immobilise them for the fatal throat-cut they have to be thrown or ‘cast,’ which in the case of the larger animals is sometimes arduous. Lately H. Weinberg's casting pen, which rotates on its long axis, has made casting easier for both man and beast. The shochetim, or official slaughterers, are all men of good character and specially trained.

Slaughter Houses

Every meat animal intended to be used for the food of man should be slaughtered in a slaughter house licensed by a local authority. Such slaughter houses may be either public or private. Public slaughter houses or abattoirs belong to, and are managed by, the local authority. A good abattoir is spacious and well equipped. It should be at least 100 feet from a dwelling. No part of the premises should be below ground level and they should not be approached through a shop. The building should include lairage, slaughtering hall, cooling house, refrigerating chambers, offal room, condemned meat room, destructor and manure depot. It should be well lighted and open to the breezes, with impervious walls and floors and copious water laid on under pressure. It is usually centrally placed and may, for convenience, adjoin the cattle market on one side and the dead meat market on the other. Private slaughter houses which are often small and ill-equipped, should be ratproofed, and dogs excluded.

The legislation to the above effect regarding slaughter houses is contained in Part V of the Food and Drugs Act, 1938. Equivalent provisions exist in the Burgh Police (Scotland) Act, 1892, and in the Public Health (Scotland) Act, 1897.

Enzootic Diseases

Enzootic disease or infection communicable to man may render a whole carcase dangerous or, if not communicable, may so lower its quality that the meat is unfit for human consumption. In other cases where the lesion is localised it may be possible, after excision, to utilise other portions of the animal. The following are among the conditions in animals which destroy, impair or may affect their value as sources of meat supply. They may determine complete or partial seizure of the carcase.

Actinomycosis in oxen and swine is due to Streptothrix actinomyces. *Anthrax* occurs in the ox, pig, horse and sheep. *Bacillary Necrosis* of the liver of the ox is ascribed to streptothrix or leptothrix infection. *Black Leg* or Quarter Evil, due to Clostridium chauvoei, and Malignant Oedema, due to *vibrion septique,* occur in cattle, sheep and horses. *Tuberculosis* in the horse is bovine: in the pig, bovine, human or avian. In sheep the disease is of rare occurrence.

Pyogenic Infections in meat animals include pneumonia, pleurisy, peritonitis, endocarditis, pericarditis, septicaemia, navel ill, joint ill, mastitis and septic metritis. Septic parturient fever in Leighton's view produces 'the worst class of all bad carcases.'

Braxy and *Louping Ill* are diseases of sheep. *Foot and Mouth Disease* affects cattle, sheep and pigs. In most outbreaks pigs are the first attacked. *Johne's Disease* or chronic bovine pseudotuberculous enteritis is caused by Mycobacterium paratuberculosis. *Swine Fever* or Hog Cholera attacks young pigs mainly, *Swine Erysipelas* fat or fatting pigs.

Liver-rot in sheep results from the parasitism of F. hepatica. *Cysticercus cellulosae* of the pig may be transmitted to man in pork. The adult worm is T. solium. *Cysticercus bovis,* communicable to man in beef, is the cystic stage of T. saginata. *Cysticercus tenuicollis* infests the sheep especially. The adult worm, T. hydatigena, late marginata, is a parasite of the dog. *Sturdy* and lumbar-gid are caused by Coenurus cerebralis in the brain or spinal cord of sheep. The dog is the definitive host. The adult worm is T. multiceps, late coenurus. *Hydatid,* which occurs in sheep especially, is not communicable to man by the eating of mutton or other meat. The adult parasite, Echinococcus granulosus, inhabits the small intestine of the dog and cat. *Ascaris lumbricoides* infests the pig. *Trichinosis* in the pig is communicable to man by pork. The worm is Trichinella spiralis. *Strongylosis* or parasitic pseudotuberculosis is an infestation of the lung of the sheep by Strongylus, or Protostrongylus rufescens. *Oncocerciasis* in the ox is due to *Oncocerca gibsoni.*

Ox-Warble is the lesion produced by the larvae of the oestrid flies Hypoderma bovis and Hypoderma lineatum. Sheep bot is the larva of the oestrid fly Oestrus ovis. Further details regarding metazoan parasites are set forth in Section XX.

Poorness is such inferiority of meat as is occasioned by underdevelopment, lactation, senile decay, or lack of food. *Emaciation* is a state of atrophy and loss of fat resulting from disease. *Immaturity* in the carcase of a recently born animal may be presumed if the meat is water-soaked, loose and flabby and can be perforated with the finger, or if muscular development is lacking and the capsule of the kidney oedematous. *Foetal carcases* are those of unborn or stillborn young. ‘ Slink veal ’ has a bluish-red gelatinous consistency. Such carcases should not be sold for human food. *Emergency slaughter* is the killing of an animal, suffering from disease or injury, which is unlikely to make an economic recovery, or of an animal exposed to infection. The carcase in the case of disease may show punctuate hæmorrhages, cloudy swelling, focal necrosis, enlarged lymph glands and other evidences of a toxic syndrome.

Meat Control

The carcase of the meat animal, as soon as possible after its slaughter, should be inspected in the slaughter house by a competent meat inspector with a view to determining whether it is fit, or partly fit, or not in any part fit, for human consumption. In deciding when to pass and when to seize a carcase the inspector should take as his guide the Code approved by the Ministry of Health. In cases of tuberculosis in bovines and swine, if the disease is advanced (Fig. 54) or is attended by emaciation, the inspector should seize the whole carcase. Where the disease is localised he may seize the affected organ only, or where permitted by the Code the head only, and pass the rest.

Carcases of animals slaughtered in emergency must be judged on their merits, if any. The meat of animals which have died a natural death should not be used for the food of man. The organs and capillaries are engorged with blood, and decomposition sets in rapidly in the moist blood-stained tissues.

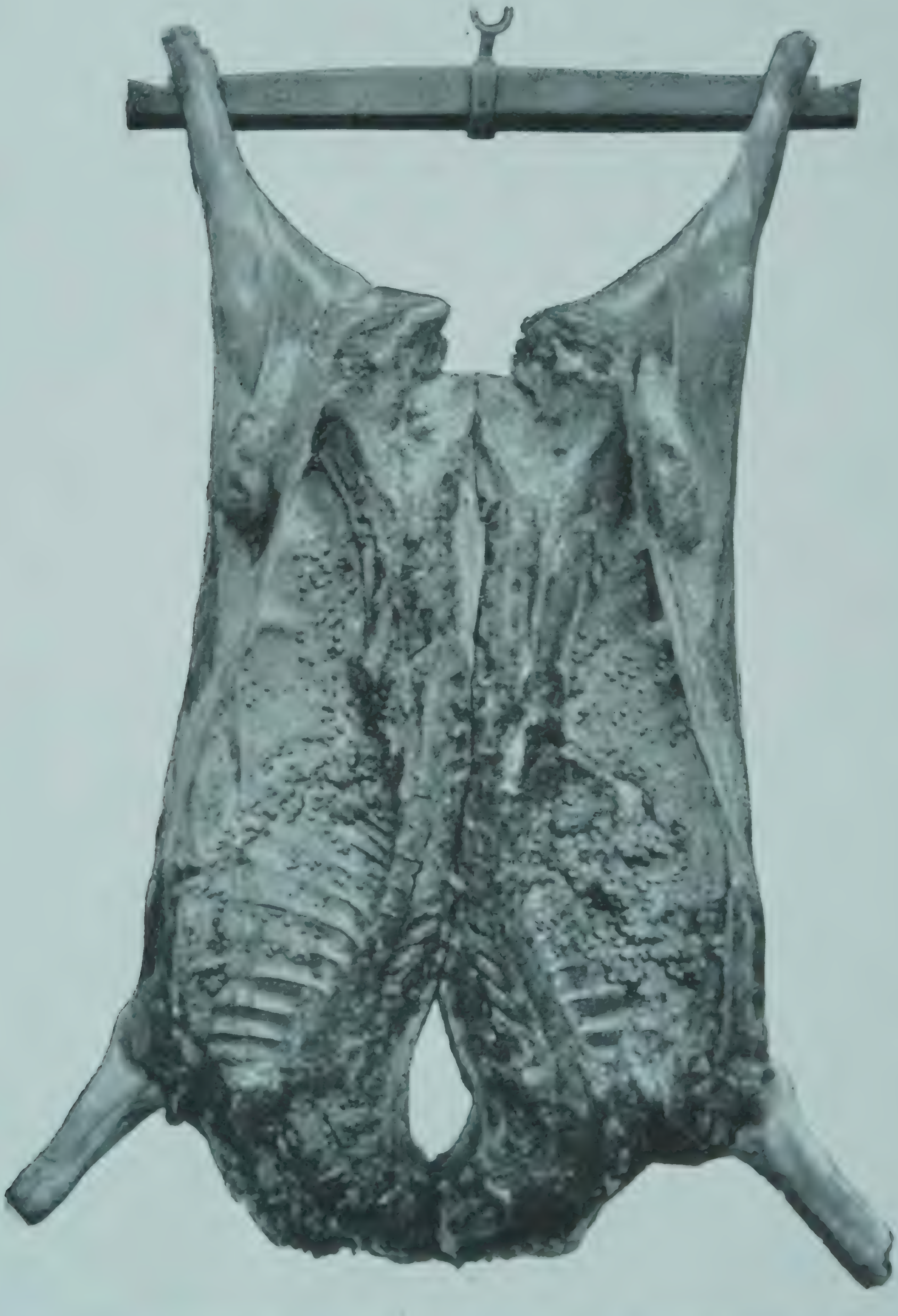

Fig. 54.—Advanced Tuberculosis of Pleura and Peritoneum of Cow.

In the case of centralised public abattoirs where slaughtering takes place according to an organised scheme the regular inspection of carcasses soon after slaughter can easily be arranged with the meat inspector. In the case of small and scattered private slaughter houses, though the current Meat Regulations prescribe either fixed hours for slaughtering or due notice of any impending slaughter, it is often difficult for the meat inspector to show up when required. Meat inspection in general is most efficiently done at the public abattoirs. The more therefore slaughtering can be centralised in a community, the more complete is the control exercised over the quality of the home-killed meat consumed in the area.

Meat Products

Meat extracts are made by heating finely divided meat under pressure, the product being evaporated *in vacuo*. They consist mainly of extractives and salts. Protein may be added for its nutritional value. Meat essences resemble meat extracts but contain more water. Meat juices are prepared by applying pressure to finely divided meat in the cold, the fluid so obtained being evaporated *in vacuo*. They contain more protein than meat extracts. Sausages are made from mince meat with the addition of bread, meal, rice or soya flour as a 'filler.' High-grade sausages contain 70 per cent. of meat: second-grade sausages 50 per cent. Sulphur dioxide is permitted as a preservative. Horse flesh is an occasional adulterant. Meat pies, pasties, potted meat and similar prepared meat foods figure from time to time in connection with outbreaks of bacterial food poisoning.

Venison

English venison is the flesh of the forest-bred fallow deer. Scotch venison derives from the roebuck. The haunch, or prime, is the most esteemed cut. Buck venison is in season from June to September. It is customary to hang the carcase, covered with powdered ginger, in a cool place until it becomes 'gamy.'

Horse Flesh

By the Food and Drugs Act, 1938, and in Scotland the Sale of Horse Flesh, etc., Regulation Act, 1889, all places where horse flesh is sold for human food must show a conspicuous sign indicating that horse flesh is sold there, and no person may supply horse flesh to a customer who asked for some meat other than horse flesh, or for some compound article of food which is not ordinarily made of horse flesh.

Horse flesh includes the flesh of asses and mules. It is darker and coarser than beef and also richer in glycogen. Horse fat is yellow and soft by comparison with the whiter and firmer fat of the ox. The horse has eighteen pairs of ribs: the ox thirteen. In the horse the fibula is present: in the ox it is vestigial. Horse bones in general are heavier than ox bones and more deeply marked.

Other distinctions are that in the horse the tongue is broad at the tip and smooth at the base: the liver is trilobate *plus* one lobule: the gall-bladder is absent and the kidney unlobulated. In the ox the tongue is pointed at the tip and roughened at the base by prominent papillae: the liver is unilobate *plus* one lobule: the gall-bladder is present and the kidney lobulated.

RABBITS AND HARES

Rabbits for food are procured by trapping, snaring, shooting or netting. They are in season from October to February. Shot rabbits are judged to be the best flavoured. The young rabbit is characterised by a tender ear, smooth claws, a stumpy neck and soft brown fur. Older animals have wrinkled ears, ragged or broken claws, thick flanks and greyish fur. The flesh of the carcase should be bluish in colour, firm, dry and cool, with white odourless fat. Frozen rabbits, in which there is a considerable trade, are liable to moulds. Coccidiosis in the rabbit resembles tuberculosis in its effects, causing emaciation and forming nodules in the liver. If the disease is generalised the carcase should be condemned. It may on occasion be necessary to distinguish the rabbit carcase from that of the cat. The kidneys in the cat are side by side: in the rabbit the right kidney is slightly anterior to the left. The liver of the rabbit is quadrilobular and that of the cat multilobular.

Hares, both native and imported, are in season from September to March and are prime during October. The hare is distinguished by its post-incisor teeth, its cleft upper lip and its hairy buccal mucosa. The young hare, or leveret, has a narrow lip cleft and possesses a small knob beneath the first joint of the forefoot.

POULTRY

The term poultry includes fowls, ducks, geese, turkeys and pigeons. Up to 30,000,000 head, either native or imported, are sold annually in the United Kingdom. The Old Sussex, the Wyandotte and the Plymouth Rock are the most esteemed breeds of table fowl. Fowls are sold as 'broilers' up to 2 lbs. and as 'boiling fowls' up to 9 lbs. 'Asparagus chicks' at 1 to 2 lbs. are favoured by hotels. *Petits poussins* at 8 to 16 ozs. are a table delicacy and are served like quails.

The healthy live fowl should show a bright, dry eye, a firm ruddy comb and glossy plumage. The ageing bird has rough legs, prominent spurs, firm unbendable beak, hard sternum and fully developed plumage without down. The pullet has smooth legs, feeble spurs, soft beak, fragile sternum and pin feathers with much down. After plucking, the bird should show a well-rounded form with a blemish-free skin and firm flesh. Favus is a fungus infection of the comb and wattles of fowls characterised by small whitish crateriform lesions. Man may acquire this disease through skin abrasions when handling infected birds.

Ducks are in season from July to February. Aylesburys are the favourite breed for table use. Ducks, when fresh, should have bright prominent eyes and moist, pliant feet. In ducklings the quills are pointed and the windpipe flexible. Staleness of the carcase is confirmed by the appearance of a greenish tinge round the vent.

The geese marketed in Britain are the White Emden, characterised by orange bill and legs, and a tall upstanding carriage, and the Toulouse, which is grey with orange-red legs and a convex back. Goslings are in season from May to Michaelmas and geese from October to March.

Turkeys are in season from November to April and the young, known as poults, from July to October. Hen birds are said to be the more palatable. The chief native varieties are the spotted Black Norfolk and the bronze-grey Cambridge, but large numbers of turkeys are imported from Ireland and the Continent.

Pigeons for food are mainly imported from France and the Low Countries and are in season from June to October. Young pigeons have soft tender feet, pinkish claws and downy feathers, while in older birds the feet are red and the spurs prominent.

The condition tests described for ducks serve also for geese, turkeys and pigeons.

EGGS

Hens' eggs vary in size and appearance. The average weight is 2 ounces. The shell forms 11 per cent., the yolk 32 per cent., and the white 57 per cent. of the total weight. The shell is composed of carbonate of lime. The yolk contains 15 per cent. of protein, 33 per cent. of fat and 10 per cent. of lecithin: the white 12 per cent. of protein and 0·2 per cent. of fat. Eggs are one of the protective foods: their protein is first-class, they have a useful content of iron and all the vitamins but C are present, A being abundant.

Dealers classify eggs by 'candling,' which consists in holding them before a light. A fresh egg is translucent when candled and the yolk is dimly seen. When placed in water it sinks. Stale eggs may display the embryo. Those showing dark spots of mould should be rejected. Duck eggs have occasioned outbreaks of food poisoning. Salmonella strains have been recovered from the eggs, oviducts and ovaries of ducks.

Dried eggs are prepared as in Method 1 for dried milk.[1] The grading and marking of eggs are controlled by the Agricultural Produce (Grading and Marking) (Eggs) Regulations, 1930.

FISH

Upwards of a million tons of fish are consumed annually in Great Britain, excluding shell fish. Some 40 varieties appear regularly in the markets. The digestibility of fish varies in general inversely as the content of fat, which ranges from less than 2 per cent. in the haddock and whiting to over 5 per cent. in the eel, salmon, turbot and herring. Fish muscle contains more calcium than beef or mutton, and fat fish like the herring, and especially fish livers, are valuable sources of vitamins A and D.

The cod family, which includes the haddock, whiting, hake and ling, is characterised by the presence of a white lateral body line and a submental bristle or barbel in cod and haddock. Flat fish include turbot, brill, halibut, plaice, sole and dab. The turbot has been called the pheasant of the sea. Halibut, which may scale at 200 lbs. and measure up to 6 feet in length, is the largest of the flat fish. The herring family includes the sprat, pilchard, mullet, skate and conger eel. Members of the salmon family are the salmon trout, common trout and char.

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[1] Page 246.

A freshly caught fish has a bright, clean aspect, prominent lustrous eyes, firm glistening scales and pink gills. Rigor begins in two or three hours and persists on an average up to a day. If the tail droops when the fish is held horizontal, rigidity is passing off. In ungutted fish the digestive juices continue to act on the contents of the intestine and finally assail the viscera themselves, which become soft and pulpy. As decay progresses the scales become detached, though trawled fish, while fresh, may show loss of scales resulting from rubs in the trawl.

A fish should be condemned if the flesh is soft and bones can be withdrawn free of tags of muscle, if any green discoloration is apparent, and if the odour is stale without necessarily being putrid. Confirmatory signs are dim sunken eyes, a grey mucus spread over the gills and, in ungutted fish, marked autodigestion. Among instances of fraud in the fish trade are the tinting of spent salmon with cochineal in order to suggest the prime state, the sale of flounders as sole and the marketing of brill as turbot.

In Japan the half-cooked carp conveys the Asiatic liver fluke to Man. In Russia and elsewhere the pike, salmon and other fish transmit to him the plerocercoid larva of the broad tapeworm. Dabs and flounders taken from polluted estuarial waters have been held accountable for cases of typhoid fever in London. Natural poisoning by fish is referred to later.

The fish mainly used in the frying trade are haddock, plaice, hake, saithe and dabs. The fish are first steeped in a flour batter, often coloured with annatto, and then fried in oil at a temperature up to 380° F. after which they are drained in wire baskets. It is important that the fish should be completely gutted before being fried. With estuarine varieties such as flounders and dabs there may be a risk of typhoid infection.

Cured fish are liable to invasion by the fish mite, by 'black spot' mould and by mildews.

SHELL FISH

The 'shell fish' of commerce are crustaceans and molluscs. The marketable crustaceans of this country are the crab, lobster, prawn and shrimp. The marketable molluscs are the oyster, mussel, cockle, whelk and winkle. Under the Food and Drugs Act of 1938, and in Scotland the Cleansing of Shell Fish Act of 1932, local authorities in England and Scotland are empowered to provide tanks or other apparatus for cleansing shell fish. Regulations as to shell fish enable English local authorities to take action with regard to layings from which infective shell fish are derived.

Crabs

These crustacea are in prime condition from April to June. The finest specimens come from Sheringham, Filey and Selsey. As many as one million crabs may be collected from 20 miles of coast line in the season. Fresh crabs should be cool to the touch, with rigid joints, and have no unpleasant odour.

Lobsters

The best lobsters come from Scotland and Norway. The average weight of the mature lobster is one and a half pounds but specimens up to 12 lbs. have been recorded. The cock lobster has 5 abdominal joints, the hen seven. The criteria of freshness are as for crabs. The tail of a prime lobster should spring sharply back when pulled out and let go.

Shrimps

The brown shrimp is estuarine, the pink shrimp marine. Shrimps are sold by the gallon equivalent to 2,700 fish. Fresh shrimps should be cool and crisp to the touch with stiff tails and prominent eyes. *Prawns* are distinguished from shrimps by the presence of a serrated snout.

Oysters

Oysters are a nourishing food. They contain from 6 to 10 per cent. of protein, from 3 to 6 per cent. of glycogen and 1 per cent. of fat. Their content of iron and copper is high, the latter sometimes high enough to tint the oysters green. Oysters contain also vitamins A and C derived from the marine vegetable plankton on which they feed. The European oyster, *Ostrea edulis*, is remarkably prolific, producing upwards of one million eggs during the season. It is usually marketed by the name of the laying whence it derived, such as 'Whitstables,' 'Pyefleets,' 'Essex Natives,' or 'Brittanys.' Portuguese or American oysters may be replanted and cultured round British shores.

As an oyster is able to circulate 10 gallons of sea water through its gills every 24 hours, oysters in sewage-contaminated layings readily become charged with infective bacteria and have been responsible for outbreaks of disease. In 1902 on a day in November there were Mayoral banquets at Winchester and Southampton. Within a few days a number of the guests at both the banquets were seized with gastro-intestinal symptoms, and some in the course of a few weeks sickened with typhoid fever, thus :

	Winchester	Southampton
Number of Guests . .	134	133
Gastro-intestinal Attacks .	52	54
Cases of Typhoid Fever .	10	11

It was found that with scarcely an exception all the sick persons had partaken of oysters, and that the supply of oysters for both banquets had been obtained from ponds at Emsworth in Hampshire. These ponds were covered with sea water at high tide, and close by was a main outfall sewer discharging sewage from houses in Emsworth in which there were cases of typhoid at the time.

Oysters, if suitably treated, are able to purify themselves of their contamination. At the Brightlingsea purification station the oysters are first hosed with chlorinated sea water to cleanse their shells, which they keep shut at this stage, and then submerged overnight in dechlorinated sea water. In this medium they open up and wash their bacteria out. The temperature of the water should be 56° F. Next day they are re-hosed and re-submerged overnight. Then after a further re-hosing and a final bath of chlorinated sea water they are despatched to market in chlorinated sacks.

Mussels

Mussels vie with oysters in their capacity to use sea water and to attach its contained bacteria. The common British species, *Anodonta sygnaea,* is in season from July to April. The purification tanks at Conway do for mussels what Brightlingsea does for oysters, and are worked on the same lines, but without similar precautions as to temperature since mussels are more chill-proof.

In 1875 illness occurred at Wilhelmshaven among persons who had eaten mussels. L. Brieger isolated from the mussels a substance, described as an alkaloid, to which he gave the name Mytilotoxin. Of attacks since then some have been thought allergic and others put down to bacterial action.

An outbreak of illness in 1927 round San Francisco comprising 102 cases with 6 deaths points to a neurotropic mussel poison. All the sick had consumed mussels from beds at a number of separate points on the Pacific shore. Tingling and numbness about the lips were followed by an ataxic gait and a feeling as if of lightness. The syndrome moved on to paralysis of the extremities, the minds of the patients remaining clear. In the fatal cases death resulted from respiratory failure. All the mussel beds implicated were, with one exception, above the suspicion of sewage contamination.

Cockles

Cockles, of which the common species is *Cardium edule*, also readily retain and transmit infective bacteria from sea water. An outbreak of typhoid fever in Glasgow was traced to cockles gathered upon the foreshore of a sea loch in Argyll where the patients had been on holiday. Some of the cases had never seen the sea loch, but owed their infection to a gift of the polluted cockles brought from the perilous fore-shore by a friend. The clam, *Mya*, and the escallop, *Pecten*, are related edible species. Other edible molluscs include the whelk, *Buccinum*, and the winkle, *Littorina*, which figure prominently in the East End of London. The annual consumption there is said to reach 1,000 tons.

The shells of oysters, mussels and cockles should be tightly closed when these molluscs are offered for sale or, if slightly open, should close at a touch. Mussels, when packed in a bag and shaken, should not rattle. The opercula of winkles should be moist and prominent.

CEREALS

The cereal grains, which are the fruits of grasses, consist mainly of carbohydrates but include also in their composition various proportions of protein; fat and other constituents. Among the staple cereals are Wheat (*Triticum vulgare*), Rye (*Secale cereale*), Barley (*Hordeum vulgare*), Oats (*Avena sativa*), Maize (*Zea mais*) and Rice (*Oryza sativa*). From cereals which are rich in gluten, such as wheat and rye, bread can be made.

Work by E. Mellanby on growing animals has suggested to him that the consumption of cereal foods may interfere with the normal development of the bones and teeth. M. Mellanby, dealing with groups of children, reported that the restraining action of vitamin D on dental caries was aided by the use of a cereal-free diet.

The people on Tristan da Cunha, 180 or so in number, owing to the superabundance of rats on that island are unable to cultivate cereals. They lived until recently mainly on milk, eggs, fish and potatoes and, when inspected in 1932 by a surgeon lieutenant commander, had almost perfect dentition. Since then ships have been landing supplies of flour and sugar so that they are now able to bake scones and bread. When their teeth were examined in 1937 by another naval officer, dental caries had increased among them and 26 per cent. showed gingivitis.

A further charge against cereals, also based on E. Mellanby's work, is that the germs of wheat and rye produce degenerative changes in the spinal cord of animals. This reaction can be prevented by the administration of vitamin A.

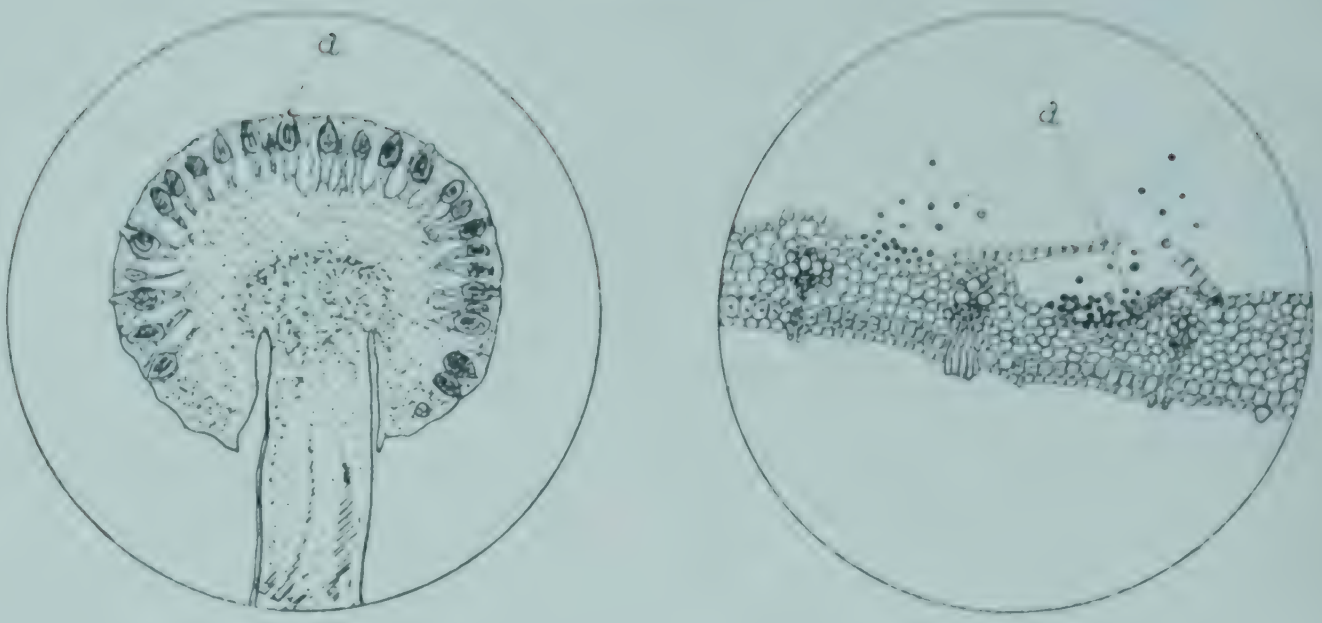
Wheat may be cultivated in any latitude from the tropics to within the arctic circle. The grain is made up of germ and endosperm, enclosed in the pericarp and testa. In the process of milling the pericarp or fruit coat and the testa or seed coat, together with adhering fragments of the aleurone layer, are detached as the bran or husk. The endosperm, 85 per cent. of the grain, is mainly starch, excepting its aleurone layer which is starch free. The germ, 1·5 per cent., is rich in protein and fat. The bran, 13·5 per cent., consists of cellulose, mineral matter and some protein. Wheat may be invaded by rust, smut and bunt.

Puccinia graminis (Figs. 55, 56), is the Rust of wheat. The uredospores of the rust attack the wheat plant in summer. The parasite comes to rest on the under surface of the leaves, where cysts form. When the cysts rupture fresh spores are freed to spread the infection down the wind. In autumn the club-shaped teleutospores appear and pass to the barberry plant, which is the intermediate host, to form on the under surface of its leaves the aecidium-spores in their cup-shaped aecidia. From the barberry a new generation of uredospores arises ready to infect the next wheat crop.

Uredo segetum (Fig. 55) or Smut is a dark inodorous surface parasite of wheat. Flour milled from such grain is dark in colour.

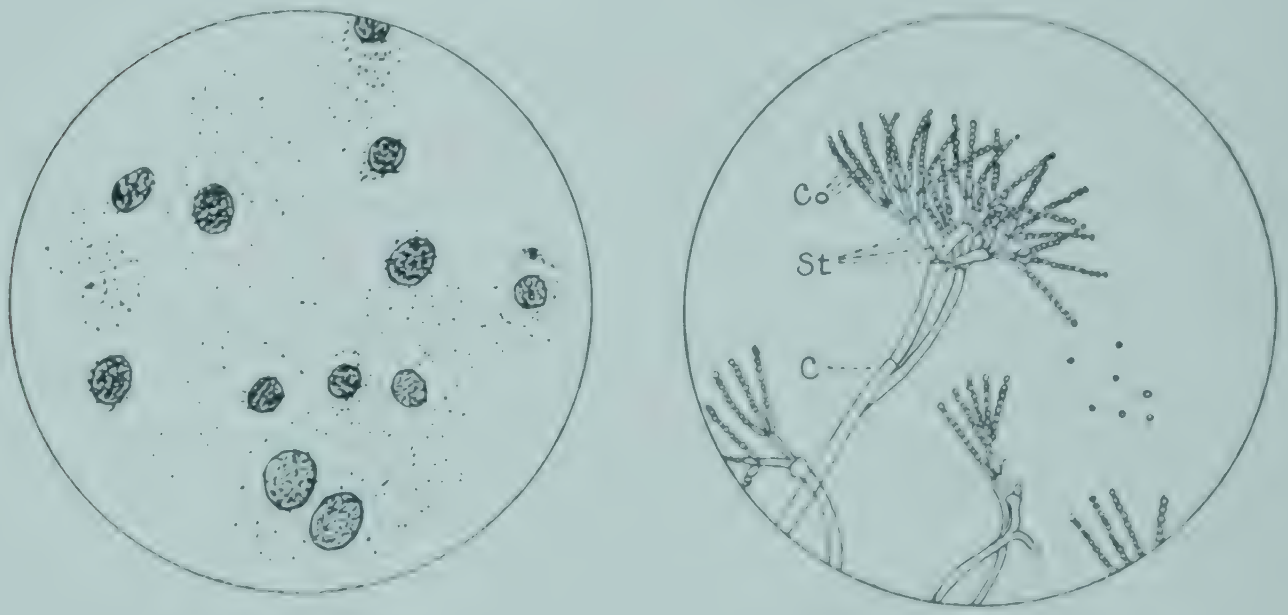
Uredo foetida or Bunt is an internal parasite of wheat. It replaces the substance of the grain by its spores, which have a disagreeable odour.

Wheat Flour. In stone milling, wheat is ground between mill stones



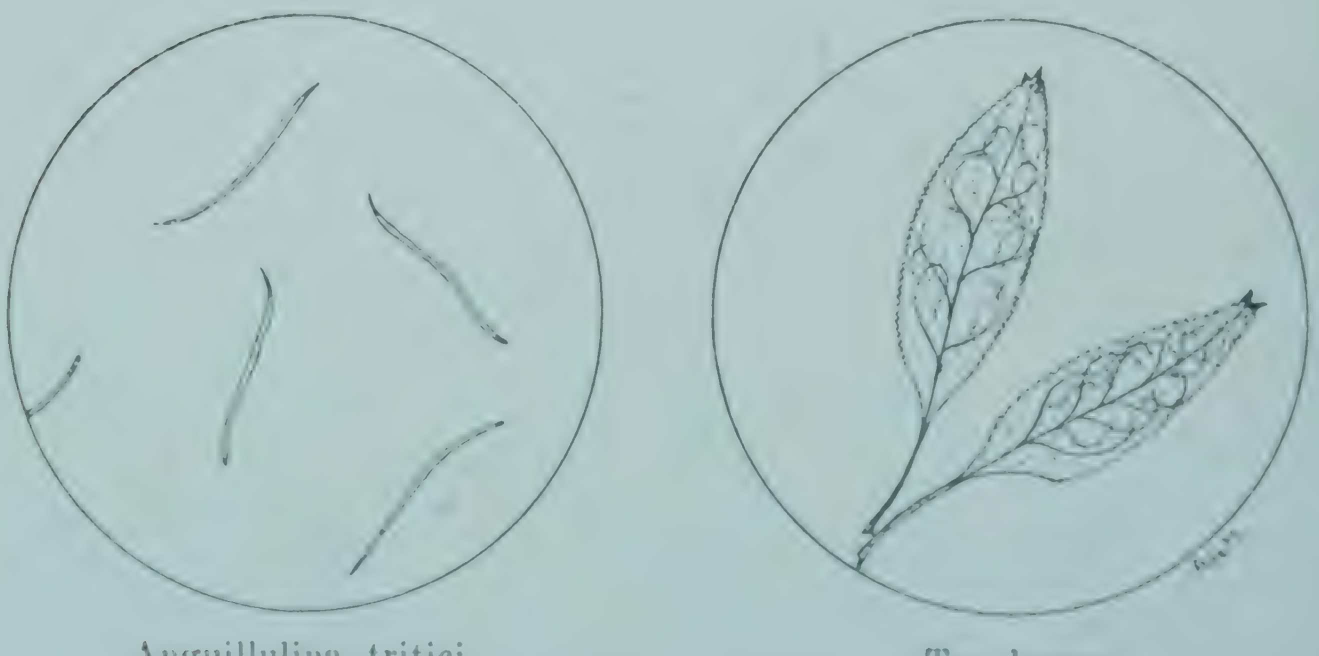
Claviceps purpurea

Puccinia graminis I



Uredo segetum

Penicillium glaucum

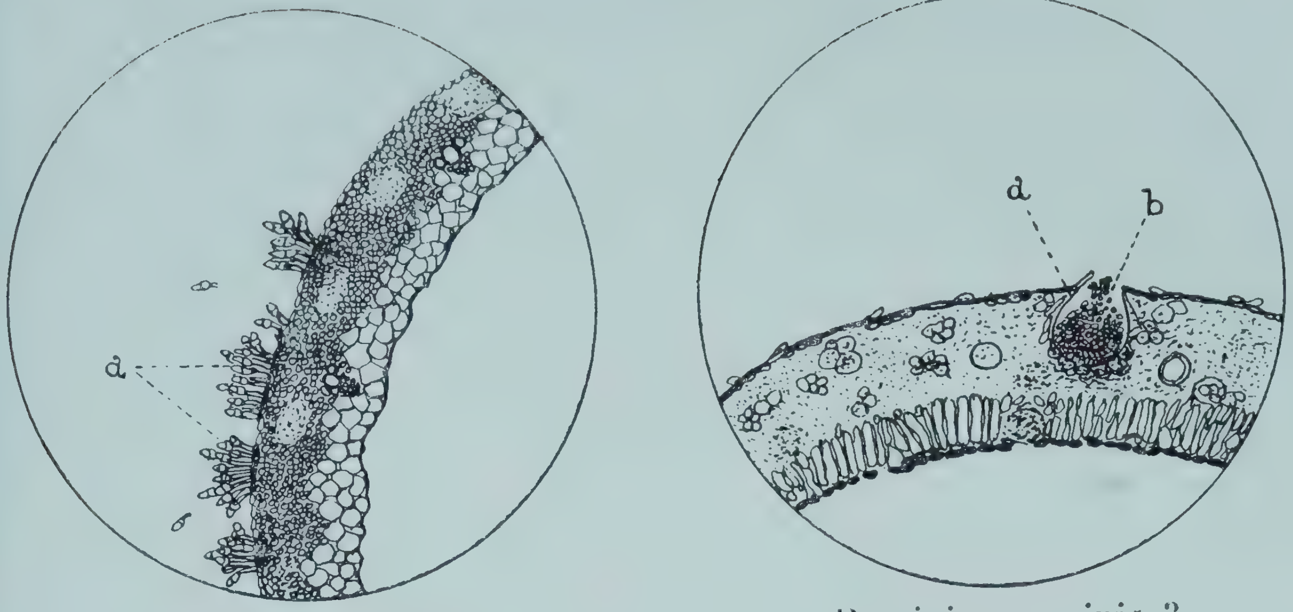


Anguillulina tritici

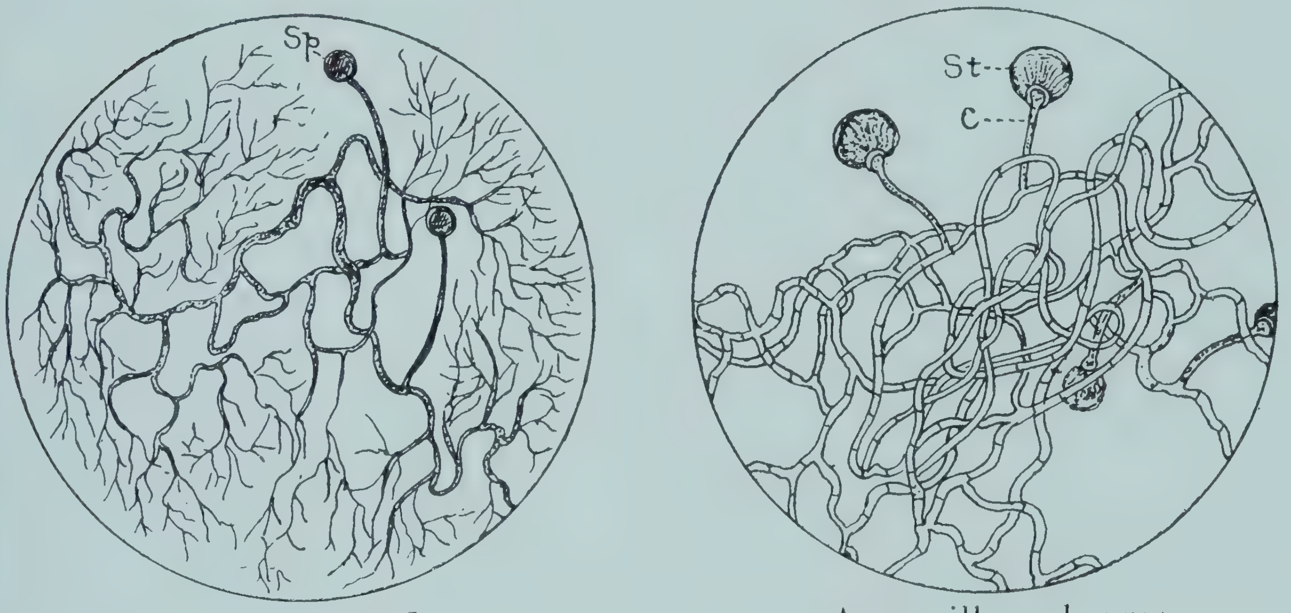
Tea leaves

Fig. 55.—Food Microscopy.

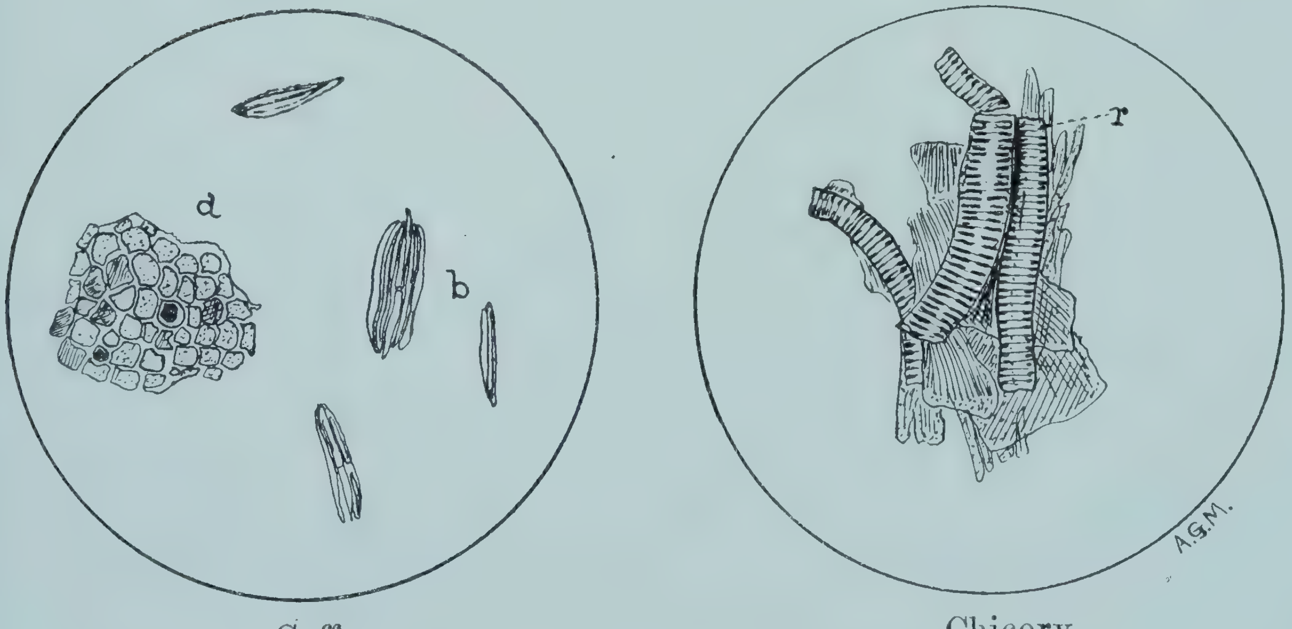
C. purpurea: L.S. through stroma. *a* = ascus.
P. graminis I: *a* = uredospores on wheat leaf.
P. glaucum: *C* = conidiophore: *St* = sterigmata: *Co* = conidia



Puccinia graminis 2 Puccinia graminis 3



Mucor mucedo Aspergillus glaucus



Coffee Chicory

Fig. 56.—Food Microscopy.

P. graminis 2: *a* = teleutospores on wheat straw.
P. graminis 3: aecidium spores in barberry leaf. *a* = cup: *b* = spores.
M. mucedo: *Sp* = sporangium containing spores.
A. glaucus: *C* = conidiophore: *St* = spore-bearing sterigmata.
Coffee: *a* = areolar tissue: *b* = testa.
Chicory: *r* = reticulated ducts.

and sifted through sieves. Its average percentage composition is as undernoted:

Water	14·4	Starch	59·7
Fat	1·4	Dextrin	7·2
Gluten	12·8	Cellulose	1·7
Soluble Nitrogen	1·8	Mineral Matter	1·0

A good flour is white with, it may be, a suggestion of golden yellow tint. All mouldy odour should be absent. Taken up in the fingers the flour should be uniformly soft without gritty particles. The dough prepared by the addition of a little water should pull out into stringy masses. The end products are a darkish flour containing the whole of the germ and endosperm, and bran and other varieties of offal, namely 'pollards' and 'middlings.' Stone milling is suitable for home-grown wheat, the husk of which is tough. It is not well suited to some oversea wheats which have brittle husks. In roller milling the grain, as it passes between successive iron rollers, undergoes a process of partial sorting. The resulting flour is of two grades. The higher grade, known as 'whites' or 'patents' and consisting of mid-endosperm only, is used for fancy-bread making by bakers: the lower grade, referred to as 'households,' which includes the whole of the endosperm, is intended for household use. For ordinary bread-making bakers employ a mixture of 'whites' and 'households.' 'Straight run' flour is ungraded.

'Standard,' 'fine meal' and 'whole meal' flour may be produced by either stone milling or roller milling. Standard flour contains the whole of the endosperm, much of the germ and the finer particles of bran. Fine meal flour is the grain with some bran removed. Wholemeal flour, which includes the whole grain with its husk, may be found of value, as an aid to peristalsis, in the treatment of intestinal stasis. The British National flour, which is of over 85 per cent. extraction, contains 7 ounces of *creta preparata* and 2 lbs. of skimmed milk powder in every 280 lbs. The extraction value of British milled flour in normal peace times averaged 72 per cent. In general white flours have a higher keeping quality than the wholemeal varieties.

To make flour take up more water and so yield more loaves, 'improvers' such as phosphates and potassium persulphate, $K_2S_2O_8$, are added to it. The bleaching of roller-milled flour is practised also, the gas nitrogen peroxide, NO_2, being most commonly used.

Bread. Dough is prepared from a leaven containing yeast and flour: later salt and more flour are added, and finally the rest of the flour. High vitamin yeasts are now available to bakers. The maltose derived from the starch is changed to alcohol and CO_2. The gas is imprisoned by the cohesive gluten, and the dough swells up into a porous mass. When the loaves have sufficiently risen they are baked in an oven at 450° F. or over to arrest fermentation, evaporate the alcohol and drive off the CO_2. Dough may be raised without yeast by forcing CO_2 through it under pressure or by using water charged with the gas. The same effect may be got by forming the dough with a baking powder. These powders usually consist of sodium bicarbonate with tartaric acid or cream of tartar or else acid calcium phosphate, put up in rice starch. The phosphate may contain gypsum as an impurity and hence show traces of arsenic. A self-raising flour is one sold with baking powder already incorporated. An average bread consists of 50 per cent. starch, 40 per cent. water, 8 per cent. protein and 2 per cent. sugar, fat and salt. Both flour and bread are liable to infestation by various fungi, including Penicillium, Mucor and Aspergillus (Figs. 55, 56). The fungi are spread by means of air-borne spores, which are carried in sporangia cups, or disposed in columns on finger-like sterigmata.

Rye, which is grown in Northern Europe, has nutritive qualities similar to those of wheat. From rye a dark-coloured bread is made. *Claviceps purpurea* is the ergot of rye. This fungus develops in the ears in spring, when the mycelium throws out hyphae terminating in knob-like stromata. The stroma is bordered by cavities or ascocarps enclosing dark oval asci (Fig. 55 a), each of which contains 8 slender ascospores. These spores, after liberation, are borne by the wind to the ovary of the rye flower and begin the cycle anew. The affected rye seeds may be purple in colour and the flour generally odorous. Consumption of such infested flour causes ergotism. Ergot may be tested for by extracting the flour with boiling alcohol and treating the decanted extract with dilute HCl, when a red coloration will denote the presence of the fungus. Another method is to heat a suspension of the suspected flour with KOH, when the fishy odour of trimethylamine becomes apparent if ergot is present.

Barley is used in the two forms of ‘ pearl ’ and ‘ patent ’ barley. The former is de-husked, and the latter de-husked and ground to flour. Barley has a low protein content and is mainly used for malting and brewing.

Oats stand high among the cereals in protein, fat and mineral content. Their husk adheres closely to the grain. Oatmeal is made by either stone grinding or rolling. If the bran is removed the product is oat flour. Oats in common with wheat, rye and barley are subject to smut (*Uredo segetum*).

Maize or Indian corn is a staple in South America, and is in considerable use in North America, South Africa and Ireland. The grain is large, and very hard owing to the close packing of starch in the endosperm. Maize is a cheap and nutritious food. Hominy is husked and fragmented maize. Cornflour is composed of maize starch. Maize has figured in investigations into the aetiology of pellagra.

Rice is rich in carbohydrate but its content of fat and protein is low. It is the staple food of many in the East. Milled or polished rice, in being divested of its germ and husk, suffers total loss of vitamin B_1, and its use as an exclusive diet has been attended by the occurrence of beriberi.

Grain, flour and other stored food products, including bacon, fruits and condiments, are subject to invasion by destructive pests, both animal and vegetable, which cause grave economic loss. The control of the animal parasites is dealt with in Section XX.[1]

[1] Page 523.

Considerable advances in the control of food infestation have lately been made by the Infestation Branch of the Ministry of Agriculture.[1] Its Area Officers are trained entomologists who are equipped with appliances to deal with every aspect of the problem, and whose advice and assistance are at the disposal of medical officers, food inspectors, grain merchants and grocery warehousemen.

OTHER VEGETABLE FOODS

The pulses contain much protein, the lentil and Soya bean being specially high. Legumin, the protein of the pulses, most nearly of the vegetable proteins resembles animal protein. The pulses contain also a good deal of carbohydrate but little fat. The fresh pulses are prophylactic of scurvy: dried pulses are not but, if soaked in water, drained, allowed to germinate for a day or two and then cooked for not more than 15 minutes, they will be found to have recovered the antiscorbutic power.

The tubers and roots contain starch but not much fat or protein. While they do not constitute a complete dietary they are useful as adjuncts. The potato is good as a substitute for the highly milled cereals. It is rich in carbohydrate and a source of vitamins B_1 and C. It contains iron also, as well as readily available Ca and P. Carrots and parsnips too are rich in carbohydrate and beetroot high in sugar. Turnips contain vitamin C.

Arrowroot is derived from the rhizome of *Maranta arundinacea*. It is an amyloid food with low protein and low fibre, leaving no residue in the intestinal tract. As compared with maize and potato starches, St. Vincent arrowroot is claimed to have a high gelatinisation point which ensures the breaking down of the starch granules. Other starchy foods are tapioca from the rhizome of *Jatropha manihot*, and sago from the pith of the sago palm.

Green vegetables like cabbage, while weak in protein and carbohydrate, contain potassium and iron salts and are sources of vitamin C. Cabbage, Brussels sprouts and cauliflower are much used in Britain. Spinach has a considerable iron content. Lettuce and cress are antiscorbutic. Tomatoes, both raw and canned, are high in vitamin A and rich in C. Bananas are a nutritious fruit on account of their carbohydrate and protein, and their alleged influence on calcium absorption. Figs, dates and raisins are sustaining by reason of their sugar. Oranges and fresh peaches and pine-apple are antiscorbutic. Brazil nuts contain 17 per cent. of protein and 66 per cent. of fat, and chestnuts over 85 per cent. of carbohydrate. The protein content of peanuts is 25 per cent. and that of almonds more than 20 per cent. Both are equally rich in carbohydrate.

The development of moulds in fruit is hastened by bruising or careless handling. On this account the finer qualities of apples, pears, oranges and lemons are usually wrapped in tissue paper. The impregnation of wrapping tissues with iodine, and o-phenyl phenol, as a prophylactic of moulds is still on trial. Blemished or 'moulded' fruit, sold at low prices to children, is not infrequently the cause of summer gastro-enteritis. Nuts when sound should sink in water. The leaves and stems of fresh green vegetables should be crisp, and snap readily when bent. The 'hearts' of cabbages, lettuce and the like, should be solid. Care should be taken to distinguish watercress from water parsnip, which resembles it closely but is poisonous. In the cress sprig the terminal leaf is larger than the stem leaves: in the water parsnip the opposite is the case.

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[1] In Scotland, the Department of Agriculture

Methods of sophistication of fruit include the brushing of block dates with treacle in order to improve their appearance, the bathing of oranges in crysoidin-stained grease so that they simulate genuine Maltese blood oranges, the concealment of unsound figs or berries in boxes by layering sound fruit on the surface and the substitution of sea kale for asparagus.

COOKING

Cooking increases the palatability of food and in general aids digestion. It disintegrates the fibre of vegetables. It softens the connective tissue of meat, which in consequence becomes more tender. At the same time the meat loses weight and volume owing to the shrinkage of its protein and the expression of its juices. Steaming and boiling cause greater losses than roasting, grilling or frying. The view has been held that meat for boiling should be sealed at the outset, in order to keep in its goodness, by sudden immersion in boiling water, but McCance and Shipp cooked two lots of meat, starting one lot in boiling water and the other in cold water which was slowly heated, and found that the ultimate losses of water, salts and weight were precisely the same in both cases: there was, they thought, no action which could be ascribed to the existence of a retaining seal. It is open to question whether under-done meat is more nutritious than well-done meat, for the latter owing to its water losses is pound for pound the richer in protein.

Cooking delays the decomposition of meat by destroying putrefactive micro-organisms. In the case of liquid foods and small pieces of meat the cooking process may be relied upon to kill most bacteria pathogenic to man. Into large pieces however the heat penetrates slowly. The centre of a joint over 6 lbs. in weight seldom reaches 140° F., the thermal death point of *B. tuberculosis* with half an hour's exposure. Thorough cooking kills the cysticerci in measly beef and pork, and is a valued defence against pork containing embryos of trichinella.

The resistance of the vitamins to the heat of cooking exhibits some variety. Vitamin D is thermostable, as also is Vitamin B_2 which survives unimpaired the temperature of 'processing' in the preservation of foods by canning. Vitamin A is not destroyed in foods cooked in the absence of oxygen. Vitamin B_1 in the course of canning suffers little or no diminution from short-time processing. Carrots can be boiled without any loss of B_1. Potatoes on the other hand, when similarly treated, relinquish one-third of their store. Bread is appreciably weaker in B_1 than the flour from which it was baked, and roast pork contains less than half the quantity present before roasting. As regards vitamin C, its heat-stability depends upon the absence of oxygen and the presence of acidity. In whole potatoes C will withstand boiling for half an hour or more, but in mashed and whipped potatoes it is soon destroyed. In citrus fruits and tomato juice C is claimed to be proof to the heat of processing.

COMMUNAL FEEDING

In this country communal feeding was already an approved feature at such centres of activity as barracks, boarding schools, universities, some day schools and many factories. During the course of the Second World War it widely extended its range, and attained to a position of some importance.

Many workers in these crowded days had to seek their principal meals elsewhere than at home. In order to give these victims of circumstance as good or better meals than they would have got at home, factory canteens were multiplied and 'British Restaurants' made available within convenient reach wherever there was a need.

It is the aim of such establishments to supply to workers satisfying and balanced meals at moderate charges. Dietetically they have an educational value, and owing to their convenient siting the dinner hour may be made less hurried by saving time otherwise lost in speeding to some distant suburb to snatch a hasty meal.

In communal cooking, which is the necessary prelude to communal feeding, the catering should be under the charge of qualified and experienced managers, who know the nutritional value of the food which they purvey, and can apply their knowledge for the benefit of those whose fitness to continue in the performance of their work is vital at this time. With a view to prompt service the communal kitchen should adjoin the communal dining room. Cooked greens, which in winter are a valued source of vitamin C, lose their virtue if there is much delay in serving them up. Another plan is to begin by heating the inedible outer leaves of the vegetable so as to produce a 'cooking water' rich in vitamin C and minerals, in which the edible inner portions can then be cooked with comparatively slight losses.

The vogue of the British Restaurants has diminished with the cessation of hostilities. It will not be so with the factory canteens. They will—or should—go on from strength to strength into the peaceful years.

BEVERAGES

Tea. The leaves of Thea (Fig. 55) are elliptical, with a notched apex and marginal serrations tipped with spines. The caffeine in tea is from 2 to 6 per cent., the tannic acid from 6 to 12 per cent. Indian and Ceylon teas contain more of both these substances than China tea. There is more tannic acid in green tea than in black tea, which is allowed to ferment before drying. The addition of milk to the tea infusion precipitates some of the tannic acid. Tea may be sophisticated by the addition of other leaves or of exhausted tea leaves treated with indigo

Coffee. The coffee bean or nib is the seed of *Caffea arabica*, obtained from the berry by pulping, drying and finally milling under light pressure. The bean, which contains 1·1 per cent. of caffeine, is roasted before use. Roasting forms caffeol, a fragment volatile oil. Coffee may be mixed with chicory, which is the root of *Cichorium intybus*, the wild endive. The addition of chicory to coffee described as pure is an adulteration. Under the microscope coffee exhibits the spindle-shaped cells of the testa: chicory shows pitted ducts with square-cut ends (Fig. 56). The so-called extracts of coffee are often mainly chicory.

Cocoa is prepared by roasting and grinding cocoa beans or nibs, which are the seeds of *Theobroma cacao*. The beans consist as to 50 per cent. of fat, and as to 1·5 per cent. of the alkaloid theobromine, which is allied to caffeine. In the course of manufacture half the fat or more is removed by pressure. The substance of cocoa is insoluble in water. Cocoa may be sophisticated by the addition of starch and by dyestuffs such as red sandal wood or venetian red. So-called 'soluble' cocoas are mixed with starch, which aids the suspension of the powder in the fluid. Dutch soluble cocoas are treated with alkali, which emulsifies the fat. Chocolate is cocoa made up with added fat, sugar, starch and flavouring agents.

Lime Juice from *Citrus limetta* and lemon juice from *Citrus limonum* contain about 30 grains of citric acid to the ounce. A genuine juice should contain only traces of chloride. The product may be adulterated by the addition of free mineral acid or salicylic acid preservatives.

The British Pharmacopoeia standards for lime juice are:

S.G. at 60° F.	1030 to 1040.
Citric acid	7 to 9 per cent.
Total Solids not to exceed . . .	14 per cent.
Ash not to exceed	3 per cent. of total solids.

The Board of Trade standards are:

S.G. (without spirit)	1030.
Citric acid	28 grains per ounce.

Natural lemon juice is a source of vitamin C: natural lime juice contains none or traces only. In terms of the Merchant Shipping Act, 1894, one or other is required to be issued to seamen daily as an antiscorbutic after 10 days out from the original port of sailing, specified routes and ports of call excepted. By the Antiscorbutics Order of 1927 concentrated orange juice of full vitamin potency may be issued instead of lime or lemon juice.

Aerated Waters. Soda Water is water impregnated with carbon dioxide. Distilled water may be used in its preparation and alkaline or other salts added, producing artificial spa waters. Lemonade, ginger ale and similar beverages consist of water sweetened, flavoured, coloured and charged with CO_2. Ginger beer contains sugar, ginger root and other ingredients. It is mildly alcoholic.

Wines are made by means of the fermentation of grape juice. Their content of ethyl alcohol ranges between 7 and 22 per cent. In a dry wine the yeast has used up all the sugar. In a sweet wine the protein is used up, and the yeast plant ceases to grow, so that some sugar remains unaltered. In the course of fermentation when the concentration of alcohol reaches 16 per cent. the yeast is killed and the process stops. This percentage is the limit for natural wines. Fortified wines, containing more than 16 per cent. of alcohol, have had alcohol added to them.

Among natural wines are claret, sauterne, burgundy, hock and tokay. Claret and hock, which contain 8 to 13 per cent. of alcohol, are examples of light wines. Burgundy is stronger than claret. Australian wines are pure natural wines equivalent in strength to burgundy.

Among the fortified wines are sherry, port and champagne. Sherry is a dry wine fortified up to 20 per cent. Marsala is like sherry but sweet. Port is fortified up to 20 per cent. or over. Champagne contains 10 per cent. of alcohol.

Gypsum may be put into wines to clarify them and improve their keeping qualities. This is called 'plastering.' Pasteurisation may be used with a similar object. In order to remove the 'iron haze' potassium ferrocyanide is added. A wine which gives the reaction for sorbitol contains cider or perry. Artificial colouring may be added to the cheaper wines. 'Medicated' wines generally have a port base to which are added albumen, phosphate and meat extract.

Beers. Pure beer is made from malt or germinating barley. The diastase of malt converts the starch of the grain into dextrin and sugar. The malt is dried and made into a mash with water. The separated infusion is the wort, which is boiled with hops. At this stage the S.G. of the wort is taken by the Excise. It is finally fermented by the addition of yeast. Beer may nowadays be made from starches other than that of barley, sulphuric acid being employed to hydrolise the starch to glucose. In the year 1900 sulphuric acid, derived from iron pyrites containing arsenic, led to an outbreak of arsenical poisoning among consumers of beer in Lancashire. In beer of average strength the proportion of alcohol is 4 per cent. Stout, prepared from roasted malt, which gives the dark colour, may contain 5 per cent. of alcohol.

Cider is the juice expressed from the pulp of mellowed apples. It contains from 3 to 8 per cent. of alcohol. Perry is a similar beverage derived from pears. Lead plant employed in cider production or delivery has given rise to poisoning.

Spirits. The spirits or strong liquors contain ethyl alcohol and extractives derived by distillation from fermented sugar. Proof spirit is a mixture of alcohol and water having at a temperature of 60° F. a specific gravity of 0·91976. The mixture contains 49·24 per cent. of alcohol by weight and 57·06 per cent. by volume. A spirit is 25 degrees under proof when it contains 75 per cent. of proof spirit, and 50 degrees under proof when it contains 50 per cent. of proof spirit. The spirits used in Britain are whisky, brandy, rum and gin. It is illegal to reduce them more than 35 degrees under proof by admixture with water.

Whisky is distilled in either a pot still or a patent still. The pot still distillate includes the extractives: from the patent still distillate most of the extractives have been separated out. Scotch malted whisky is made from a mash of pure barley malt heated in a pot still over an open flame. It is rich in extractives and highly flavoured. Irish whisky, which also has a distinctive flavour, is distilled in a pot still from a mash of malted barley mixed with unmalted grain. Grain whisky is prepared by means of a patent still from a mixture of various grains with malt added. Most of the extractives are kept out of the distillate, and the resulting liquor is known as 'silent' spirit. A blended whisky is usually a mixture of malted whisky with silent spirit.

Brandy is distilled from fermented grape juice. It becomes bland on keeping. Brandy blended with silent spirit ranks as inferior to pure brandy. Rum is prepared from fermented sugar-cane juice or fermented molasses. Its colour is due to burnt sugar. Gin is made from a mixture of malt and rye flavoured with juniper berries or oil of juniper. Whisky, brandy and rum have the same alcoholic content, which is approximately 40 per cent. Gin is a little weaker.

OTHER FOODS

Mustard is the ground seed of *Sinapis alba.* Pure mustard contains 30 per cent. of the essential oil of mustard, but the manufactured product may show less since manufacturers occasionally add starch to prevent the caking of mustard in bulk. Sophistication of mustard may be practised by the addition of extraneous starches, which are detected by microscopic examination. Occasionally turmeric is present. It is tested for by adding ammonium hydrate which shows it up as red specks in the mustard when viewed with a hand lens.

Pepper is the dried fruit of *Piper nigrum.* Adulteration is by addition of starch, chiefly rice, and poivrette. The starch is discriminated microscopically and the percentage present may be gauged by comparison with standard mixtures. Poivrette is a preparation of powdered olive kernels and walnut shells. Another adulterant is Long Pepper (*Chavica roxburghii*).

Vinegar. Natural vinegar is produced by the acetous fermentation of cereal grain or alcohol. It contains principally acetic acid, extractives and small quantities of alcohol and sugar. The organism concerned in the process of fermentation is the *Mycoderma aceti.* 'Wood' vinegar is an artificial product consisting of diluted acetic acid with added caramel to impart a colour. Malt vinegar may be sophisticated by the addition of mineral acid, or by the partial replacement of its bulk by wood vinegar. The critical test in differentiating malt from wood vinegar lies in determination of the phosphate, which is always definitely present in the natural product but rarely in the synthetic. When free mineral acids have been added, the ash from the vinegar is neutral. An alkaline ash indicates the absence of mineral acids. Pure malt vinegar should contain not less than 4 grams of acetic acid, and not more than 0·0143 mg. of arsenic, per 100 ml. Potassium ferrocyanide, sometimes used to clarify vinegar, may produce traces of HCN. Malt vinegar may on occasion become infested by *Anguillulina,* the 'Vinegar Eel' (Fig. 55).

Jams. These may be sophisticated by the addition of starch and apple pulp or vegetable marrow, and commercial glucose instead of cane sugar. Apple pulp is detected by the addition of iodine which turns the apple starch blue. Agar is sometimes added as a stiffening agent. Pectin, which is often added to strawberry jam, does not constitute an adulteration if a statement of its presence appears on the label of the jar. Artificial pips of wood have been found in raspberry conserves. The water content of jam should not exceed 25 per cent. Sulphur dioxide is permitted in jams and jellies up to 40 parts per million. In terms of a memorandum issued by the Federation of Food Manufacturers, first-quality jams should contain a minimum of 30 per cent. of fruit, and second-quality jams at least 20 per cent.

Honey. Honey is the sugary exudate of plants as collected and stored by *Apis mellifica*. Dextrose and laevulose are present in almost equal proportions. Examined polarimetrically a 10 per cent. solution of honey should show laevo-rotation. Dextro-rotation suggests the addition of cane sugar or starch glucose. The maximum for water is 25 per cent. Artificial honey, prepared from cane sugar or syrup, has a low ash content and little or no phosphate. Natural honey comb chars with concentrated sulphuric acid: artificial comb, usually made from paraffin wax, is unaffected. The sediment from a centrifugalised aqueous solution of natural honey, when examined microscopically, reveals pollen grains.

Sugar. Table sugar should contain 1 per cent. water and less than 1 per cent. ash. Ultramarine blue may be added to whiten sugar. If a solution in water of a sugar so treated is allowed to stand overnight the blue dye sinks to the bottom of the vessel.

Syrup and treacle contain up to 50 per cent. of cane sugar. They should not carry more than 20 per cent. of water. The balance is mainly invert sugar.

FOOD PRESERVATION

Ordinary foodstuffs in their natural state are all more or less perishable. Moist foodstuffs are specially so, offering as they do a favourable medium for the growth of the micro-organisms of decomposition. In order that such foods may be stored at their place of production for use locally later, or transported elsewhere to serve the needs of consumers at a distance, methods of preservation are used to keep them in good condition. Among such methods are salting, pickling, sugaring, glazing, drying, smoking, refrigeration, gas storage, canning and the addition of chemicals.

SALTING. Meat and fish may be preserved in 18 to 25 per cent. salt solution. The brine checks bacterial growth but causes hardening of fibre and loss of extractives. Dry salt, in the proportion of 15 lbs. to every 100 lbs. of meat, may also be used, but the wet method is to be preferred.

PICKLING. Pickle consists of vinegar flavoured with peppercorns, mace, cloves, ginger or other spices. Pickling is used for vegetables such as red cabbage, gherkins and onions, and nuts such as walnuts. Sweet pickles are made from plums and similar fruits.

SUGARING. Jams and jellies are preserved by means of sugar. The heating process inverts sucrose. In some commercial jams glucose is the original preservative.

Glazing. Eggs may be preserved by immersion in water-glass, which is an aqueous solution of sodium silicate. Bacteria are thus excluded from eggs with undamaged shells. It is vain to glaze chipped eggs.

Drying. The process of drying withdraws from food a good deal of the moisture required by bacteria. About 6 per cent. of water remains on the completion of the dehydration. Vitamins B_2 and D are said to be unimpaired by drying. The content of vitamin C is lowered. Dried foods keep for long periods. Fruits, and meat cut into strips, can be dried in the sun. Fish, after being slit open, are hung to dry in the air or artificial methods are used. Dried milk and dried eggs are prepared by special processes.

Smoking. Fish, meat and bacon may be preserved by means of wood smoke from smouldering oak, beech, hickory or deal sawdust. The efficacy of the method is due partly to the drying effect, partly to the germicidal action of the creosote produced in the combustion. Smoking is generally preceded by salting. Imperfectly salted meat does not smoke well and is liable to subsequent decomposition. 'Puffed' ham exemplifies bacterial fermentation in a smoked foodstuff which has been incompletely pre-pickled.

Refrigeration

The nutritional qualities, flavour and digestibility of foodstuffs are unimpaired by refrigeration and their vitamin content is not significantly lowered.

The low temperatures necessary in refrigerating chambers are commonly maintained by means of brine which has been cooled by the evaporation of liquid ammonia, carbon dioxide, chlormethane or other substance. The cold brine circulates in pipes through the chamber or it may be used to cool the entering air. For each class of food submitted to refrigeration an optimum temperature is recognised. Imported meat is carried at sea either chilled or frozen. For the chilling process the range of temperature is between 28° and 30° F., and the temperature within these limits should be kept as even as possible. For the freezing process the range is quoted as between 10° and 15° F. The temperature must not be allowed to rise above the upper limit, but a fall considerably under the lower is of little moment. Meat intended for refrigeration should be well bled, thoroughly dressed and hung for 36 hours. It should be handled only by cleanly personnel. A high glycogen content improves the keeping quality of meat which is to be chilled. Strict cleanliness is required in the previous handling of meat intended for chilling: otherwise moulds picked up in the slaughter house or packing room may overgrow it in cold storage and render it unsaleable. Such are *Cladosporum herbarum* or 'black spot,' *Sporotrichum carnis* or 'white mould' and varieties of *Penicillium*. Cladosporum is a penetrating genus. It develops rapidly on beef and mutton and may invade the meat to a depth of ¼ inch. The growth of moulds in such circumstances is accelerated by conditions of increased humidity and air stagnation, by prolonged storage and by too frequent handling of the carcases. Fish frozen in brine at 4° F. will keep for 3 months. In the 'sharp freeze' method largely employed in Canada, fish are frozen at or about 0° F., so becoming enclosed in a thin coating of ice. Fruit does not do well at very low temperatures, but strawberries and raspberries, which usually stand transport badly, will remain in good condition for short periods if cooled to 40° F. immediately on gathering.

Chlormethane escaping from domestic refrigerators caused a number of deaths in Chicago a few years ago. Among the symptoms noted were stupor, vomiting, tremor, mydriasis, ptosis, pyrexia and anuria. In the fatal cases the autopsy revealed congestion of the viscera and fatty degeneration.

Strongly odorous foodstuffs should be kept in covered glass dishes whilst in a domestic refrigerator. Non-mechanical ice box refrigerators are not to be recommended. The moist, stagnant air which they contain favours the growth of mildews.

The inspection of refrigerating plant should include an examination of the insulating system, maximum and minimum temperature readings, hygrometry and a velometer estimate of air speed in the chambers.

Gas Storage

In the case of some foods, storage in the presence of carbon dioxide has been found to exercise a preservative action. In an atmosphere moderately charged with this gas chilled beef has been kept in good condition up to 70 days. A method of preserving eggs in France is to hold them at 1° C. in an oxygen-free atmosphere containing 88 per cent. of CO_2. Apples too, at temperatures above freezing-point, have been stored in low concentrations of CO_2 with good results. Tomatoes keep well in a mixed atmosphere of oxygen 5 per cent. and CO_2 5 per cent. Another gas, ethylene, C_2H_4, in a concentration of 1 in 10,000, hastens the ripening of green bananas, and iodine vapour liberated from iodised wrappers retards the decay of grapes and oranges.

The practice of storage in CO_2 has recently been extended to meat-carrying ships from the Argentine. Special hermetic chambers with remote gas control are required. The concentration of the gas must not exceed 20 per cent., else oxidation of the fat occurs.

Canning

The practice of preserving foods by storage in sealed glass containers after heating originated with Nicolas Appert of Paris in 1804. Durand, some six years later, employed tins. From these early beginnings the development of the canning process has been rapid and it is now a highly specialised department of the food industry. The establishment at Campden in 1923 of the Fruit and Vegetables Preservation Research Station has done much to further the scientific study of food canning and its problems.

The advantages of the can are claimed to be: it offers perfect protection: its heat conductivity is high, so permitting of rapid heating and cooling: it is sufficiently strong to withstand vacuum: it does not contribute objectionable flavours to food: it is hygienic, since it is used only once: it can be made in any convenient size and shape: and it is inexpensive.

Canning on the large scale is effected by machinery, which limits handling and reduces contamination. The can is made of mild steel plate coated with tin and lacquered by an electrical process. As the tin coating is extremely tenuous some points of the steel surface may be left bare, so that with acid fruits or marine products a tin-iron couple is formed and hydrogen set free. The lacquering of the inside of the cans, if imperfectly done, is said to increase the electrolytic action.

There are two principal forms of can, the 'hole and cap,' now obsolescent, and the 'sanitary.' In the hole and cap type the food, prepared by previous heating, is introduced into the can through a good-sized circular opening in its top. The 'hole' is then closed by means of a 'cap' with overlapping margins, and the margins are soldered down. In the sanitary type the whole lid, after filling, is fixed on by crimping without solder. Rubber solution or paper is employed to make the double seam tight.

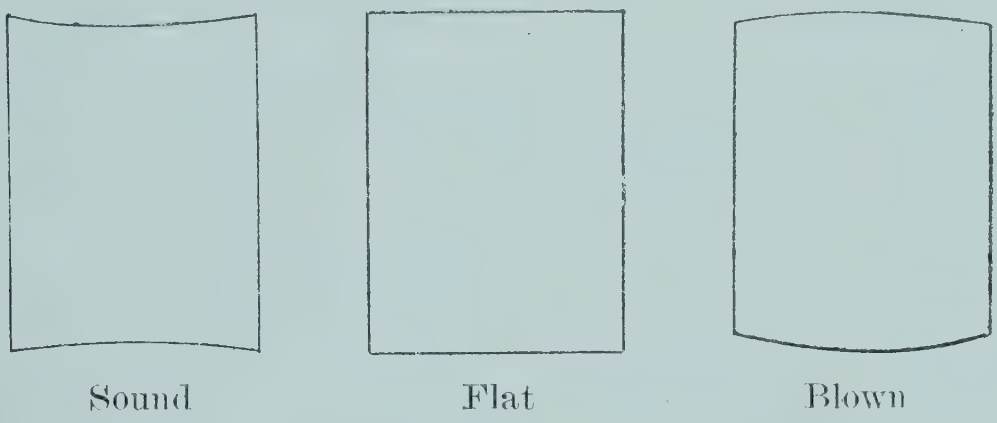


Fig. 57.—Food Cans.

The next step is to exhaust as much air as possible from the can. This is done either by making and then soldering up a small hole in the lid in a vacuum-sealing machine while the contents of the can are still cold, or else by puncturing the heated can in the open to allow hot air and steam to escape, soldering the puncture immediately and then cooling the can. Either way, a negative pressure, equivalent to some 25 inches of mercury, results and the ends of the can are in most cases concave.

The third stage, which is called 'processing,' is the heating of the food in the filled and sealed can in a rotary retort to ensure its keeping in good condition. The temperatures employed go up to 240° F., which is high enough to check bacterial growth but not so high as to alter the appearance of the food. Observations made suggest that complete sterility is not essential. W. G. Savage, examining a range of sound samples of various canned foods, found that 38 per cent. were non-sterile. On completion the cans may be re-lacquered outside to prevent corrosion.

The final stage is the rapid, though carefully controlled, cooling of the cans.

Food intended for canning should be of prime quality and, in the case of fruits, exactly ripe. Meat is generally packed in jelly, vegetables in brine, fruits in syrup and fish in olive oil or tomato sauce. Fruit juices may be pasteurised by the H.T.S.T. method before canning.

The spoilage of canned foods points to bacterial activity, most often a consequence of under-processing or leakage. The most unpleasant decomposition is produced by obligate anaerobes and aerobic non-sporing *Proteus* strains. The admission of air through a puncture in a can causes the aerobes to grow first: then the anaerobes awake to activity, thriving upon the degradation products of the others. Spoilage tends to be prevented by the use of strong cans, effective sealing and adequate processing. Canned foods, like other prepared foods, may contain pathogenic bacteria such as those of the Salmonella group or *B. botulinus.* The intrusion of organisms of this class is prevented by careful selection of the raw material at the outset and the use of machinery, together with scrupulous cleanliness, at every subsequent stage of production. Certain strains of thermophilic bacteria may survive the processing temperatures and become responsible for spoilage especially in canned cream, to which they impart a bitter flavour. The contents of a spoiled can are generally soft in consistency and paler than usual in colour. The can empties easily and any liquor present is frequently opaque.

TABLE 29.

From First Schedule, Part I., of Public Health (Preservatives etc. in Food) Regulations

Chemical Preservatives

Foodstuff.	Preservative.	Parts per Million Allowed.
Sausages	Sulphur Dioxide	450
Fruit and Fruit Pulp	" "	1500-3000
Dried Fruits	" "	750-2000
Jams and Jellies	" "	40
Crystallised Fruits	" "	100
Gelatin	" "	1000
Beer	" "	70
Cider	" "	200
Alcoholic Wines	" "	450
Corn Syrup	" "	450
Mince (June to Sept.)	" "	450
Unfermented Grape Juice and Non-Alcoholic Wines made therefrom	Benzoic Acid	2000
Ginger Beer	" "	120
Coffee Extract	" "	450
Pickles and Sauces	" "	250
Cordials and Fruit Juices and Other Non-alcoholic Wines	Either Sulphur Dioxide or Benzoic Acid	350 600
Sweetened Mineral Waters	" "	70 120

Canned foods may take up lead from solder but the quantity is negligible. They may take up tin also, of which 2 grains to the lb. has been quoted as possibly deleterious. As regards vitamin content the vitamins classed as thermostable are in general proof to the temperatures of processing. Those reckoned thermolabile show considerable heat resistance, since vacuum-sealing implies a minimal concentration of oxygen.

While cans with concave ends are sound, those with flat ends may or may not be so (Fig. 57). A rusted can with flat ends has probably developed a puncture. When a punctured can is submerged in hot water bubbles rise up from the orifice. A dented or otherwise deformed can should be viewed with suspicion. A 'blown' can with convex ends contains the gases of decomposition. Occurring with fruit or marine products this phenomenon may be a 'hydrogen swell' of electrolytic origin. Since there is no way of differentiating between decomposition and the hydrogen effect, save by microchemical analysis, all blown cans should be regarded as unsound. Convexity of the ends, in the absence of gas, may be due to overfilling.

Table 30.

From First Schedule, Part II., of Public Health (Preservatives etc. in Food) Regulations

Prohibited Colours

I. *Metallic Colouring Matters*		
	Antimony	Copper
	Arsenic	Mercury
	Cadmium	Lead
	Chromium	Zinc
II. *Vegetable Colouring Matter*		
	Gamboge	
III. *Coal Tar Colours*		*Synonyms*
	Picric Acid	Carbazotic Acid
	Victoria Yellow	Saffron Substitute: Dinitrocresol
	Manchester Yellow	Naphthol Yellow: Martius Yellow
	Aurantia	Imperial Yellow
	Aurine	Rosolic Acid: Yellow Coralline

Canned foods are examined by inspection, percussion, palpation and shaking. Inspection should be directed especially to the seams and end-junctions of the container. Cans blown by gas yield a tympanitic note when struck, sound cans a dull note. Partially blown cans may be detected by palpation, the ends imparting a sense of resistance to the examining finger. Meat packs should not show evidence of the presence of fluid when shaken.

Mainly as the result of research during the Second World War, a revolutionary method of canning is now available to British packers. The cans, which are rectangular, or triangular, and seamless, and may be of tinplate, monel metal or aluminium, are fabricated actually in the packing line. After filling, the cans are closed by a vacuum double seamer whence they pass into a dry heat processing oven where they are subjected to three zones of temperature.

Another result of wartime research is the 'chemical cooker' can, which incorporates a thermite element in the lid construction. On applying a lighted cigarette to the special fuse, the element becomes activated and the contents of a 16 ounce can are ready to be served hot within five minutes.

Food may be put up in glass containers, and toughened glass is now available for this purpose. The container is closed by means of a lacquered tin cap provided with a cardboard or wax paper 'liner.' In the 'phoenix' type the cap is reinforced by a metal collar, and a partial vacuum in the glass container holds the metal lid in position, an air-tight seal being effected with the aid of a rubber gasket.

Crystals of ammonium-magnesium phosphate, which tend to deposit in glass-packed and canned marine products, may closely simulate spicules of glass. The distinction is readily made by immersing a portion of the suspect food in vinegar, when the spicules, if phosphate, will rapidly dissolve.

Chemical Preservatives

Chemical preservation of foods is intended to retard or arrest fermentation. It is a simple and inexpensive method and, properly conducted, offers no risk to the consumer. Chemical preservative in excess may however serve to aggravate an existing dyspepsia.

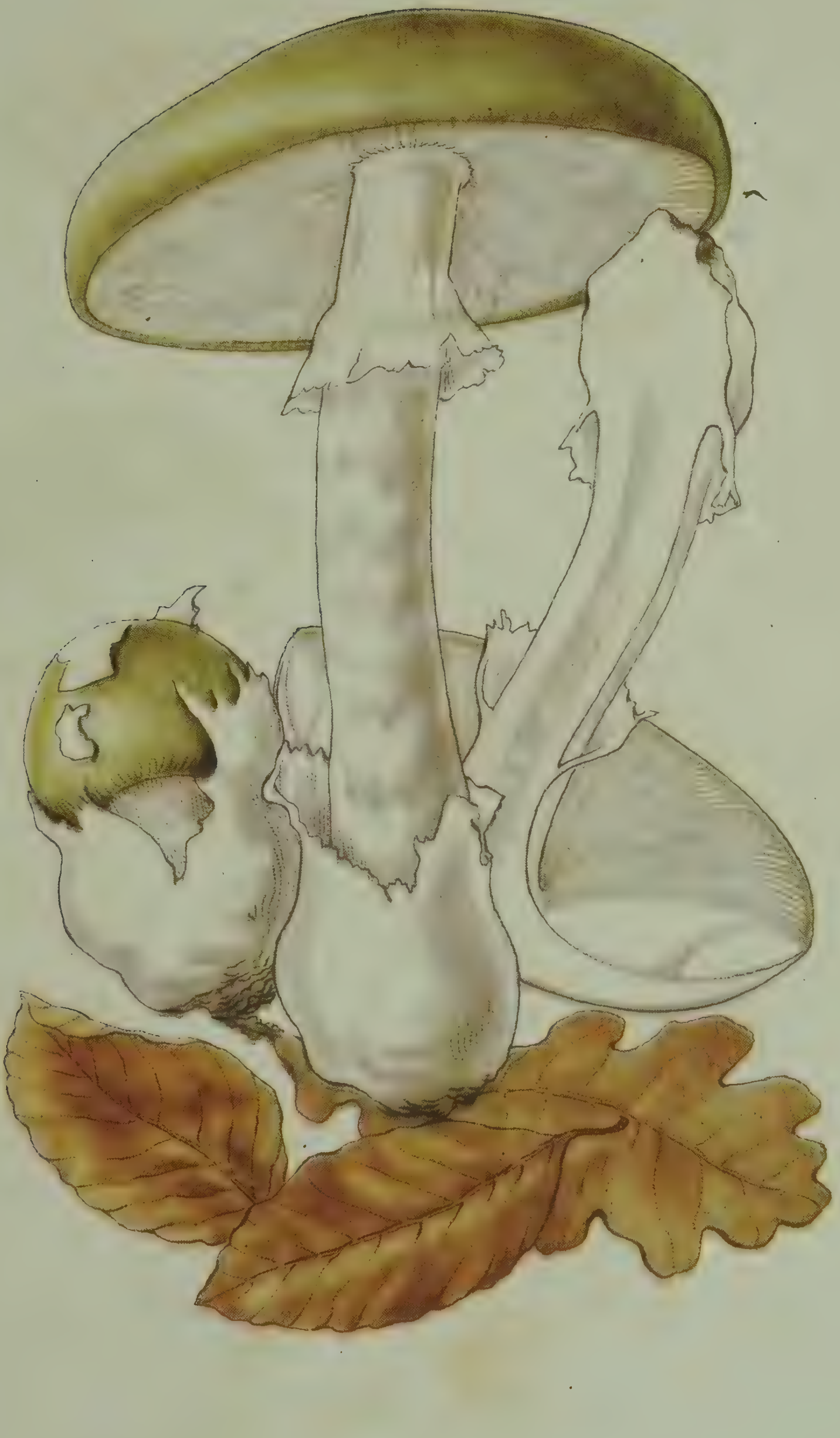
In terms of the Public Health (Preservatives, etc., in Food) Regulations, 1925 to 1940, which have been made for both England and Scotland, two chemical preservatives only are permitted to be put into foods. These are (1) sulphur dioxide, including sulphites and (2) benzoic acid, including benzoates. Further, they are permitted to be put into specified foods only. The Regulations also forbid the addition of certain colouring matters to articles of food. Table 29 exhibits the specified foods and the quantities of the named preservatives permitted to be added to them. The prohibited colours are listed in Table 30.

An officer of the local authority may take samples of the foods for analysis. Non-compliance with the Regulations, as ascertained and certified by the public analyst, is an actionable offence.

Sausages and sausage meat, coffee extract, pickles and sauces, mince meat and, in certain cases, grape juice and wine, where they contain preservative, must bear a label to that effect or the vendor must display a notice to the same purpose, except in hotels and restaurants.

In 1940, as a war emergency measure, borax was authorised to be added to bacon and margarine and $NaNO_2$ or KNO_2 to bacon and ham.

It should be noted that for the purposes of the regulations the term 'preservative' does not include common salt, saltpetre, sugar, lactic acid,



Amanita Phalloides

From "Poisonous Fungi" by John Ramsbottom.
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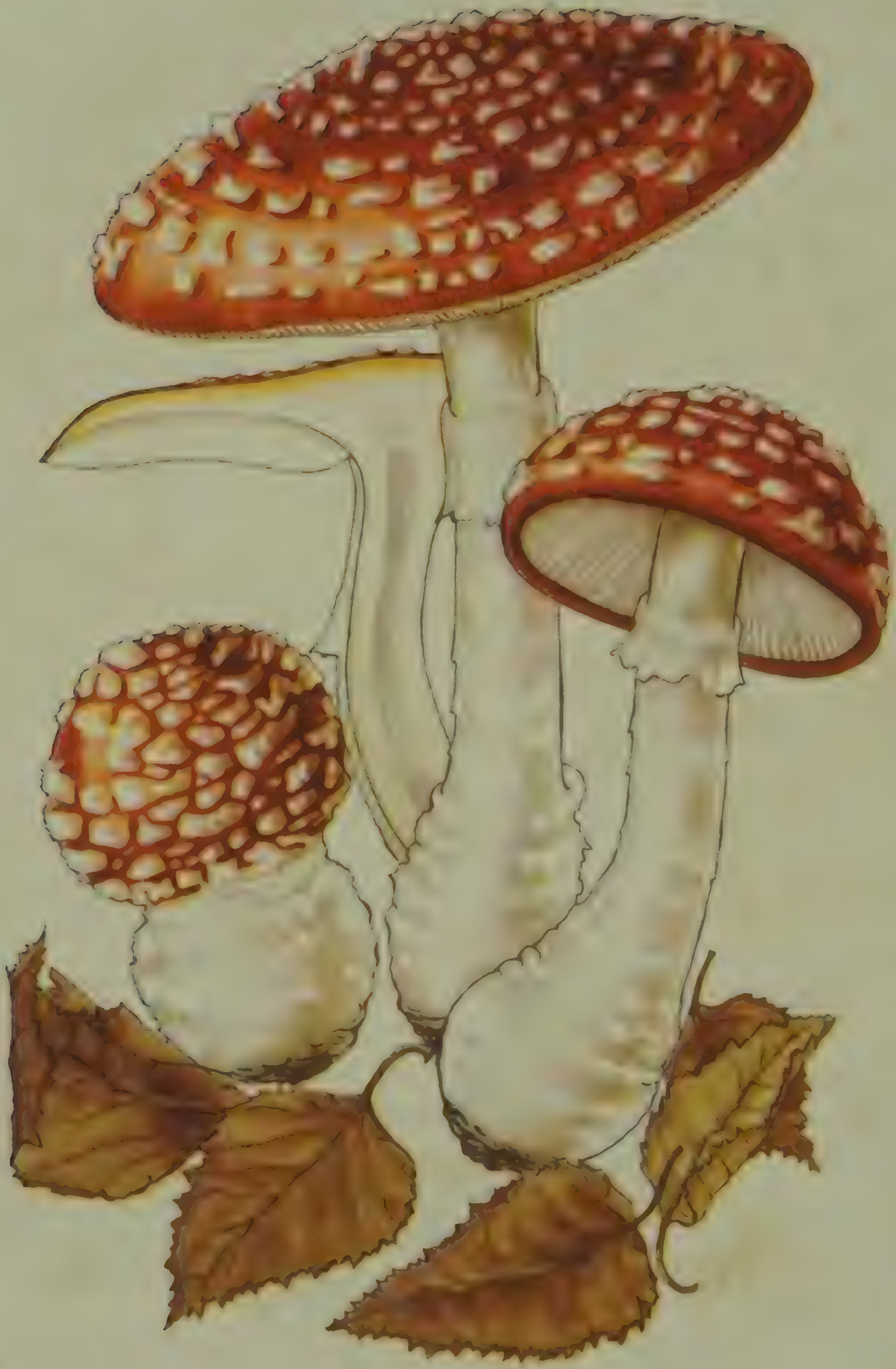


Amanita Muscaria

From "Poisonous Fungi" by John Ramsbottom. By kind permission of the author and Messrs. Penguin Books, Ltd.

acetic acid, glycerin, alcohol, spices, essential oils or any substance added to food by the process of curing known as smoking.

Among the illicit chemical preservatives which appear in food from time to time are boric acid, salicylic acid and formaldehyde.

In the United Kingdom there is no statutory list of permitted colours for foods. Synthetic yellows, reds, blues, greens and other shades scheduled in some British Dominions and foreign countries for use in foods are detailed in 'The Colouring of Food Stuffs' issued by Messrs. British Drug Houses Ltd. Permissible 'native' colours include annatto, caramel, cochineal, cudbear and saffron.

FOOD POISONING

Poisoning by food may exhibit every grade of severity ranging from slight indisposition to a fatal issue. The various forms of food poisoning may be classified as those originating from (1) Plant Sources, (2) Animal Sources, (3) Metals, (4) Chemical Poisons, (5) Allergy, (6) Bacterial Food Poisoning and (7) Botulism.

Plant Sources

Poisonous mushrooms eaten in error cause some loss of life on the European continent and in the United States. The deadliest species is *Amanita phalloides* (Plate I.), which produces a case mortality of 60 to 100 per cent. Ingestion of the mushroom is quickly followed by abdominal pain, choleraic diarrhoea and blood in the stools. Strength progressively fails, uraemic coma develops and death in fatal cases takes place within a week of onset. *Post mortem* the liver and kidney exhibit fatty degeneration. Another species, *Amanita muscaria* (Plate II.) contains the alkaloid muscarine, which, by acting on the parasympathetic, contracts the pupil, causes convulsions and arrests the heart in diastole. The edible mushroom, *Agaricus campestris,* grows in dry, airy places, is usually white, does not change colour when cut, shows a watery juice and has a bland taste. The poisonous varieties generally grow in clusters in damp situations, are brightly tinted, change colour when cut, often show a milky juice and have a bitter or astringent taste. The gills of *Amanita,* however, are permanently white.

The potato poison is solanin, which is present in toxic concentration in prematurely gathered and sprouting potatoes. The symptoms produced by solanin are gastro-intestinal. In the Glasgow outbreak of 1917 there were sixty-one cases. In the outbreak among the garrison of Berlin the quantity of solanin in the potatoes consumed was six times that in ordinary potatoes. In the Cyprus outbreak of fifty cases in 1932, when the young shoots of the potatoes were eaten, the quantity of solanin in the shoots was five times that in the tubers. Some attacks of illness associated with the potato have been of bacterial origin.

The rhubarb plant contains oxalic acid, which is specially abundant in the leaves. At the beginning of the First World War the incautious recommendation that people 'should not waste rhubarb leaves' led to

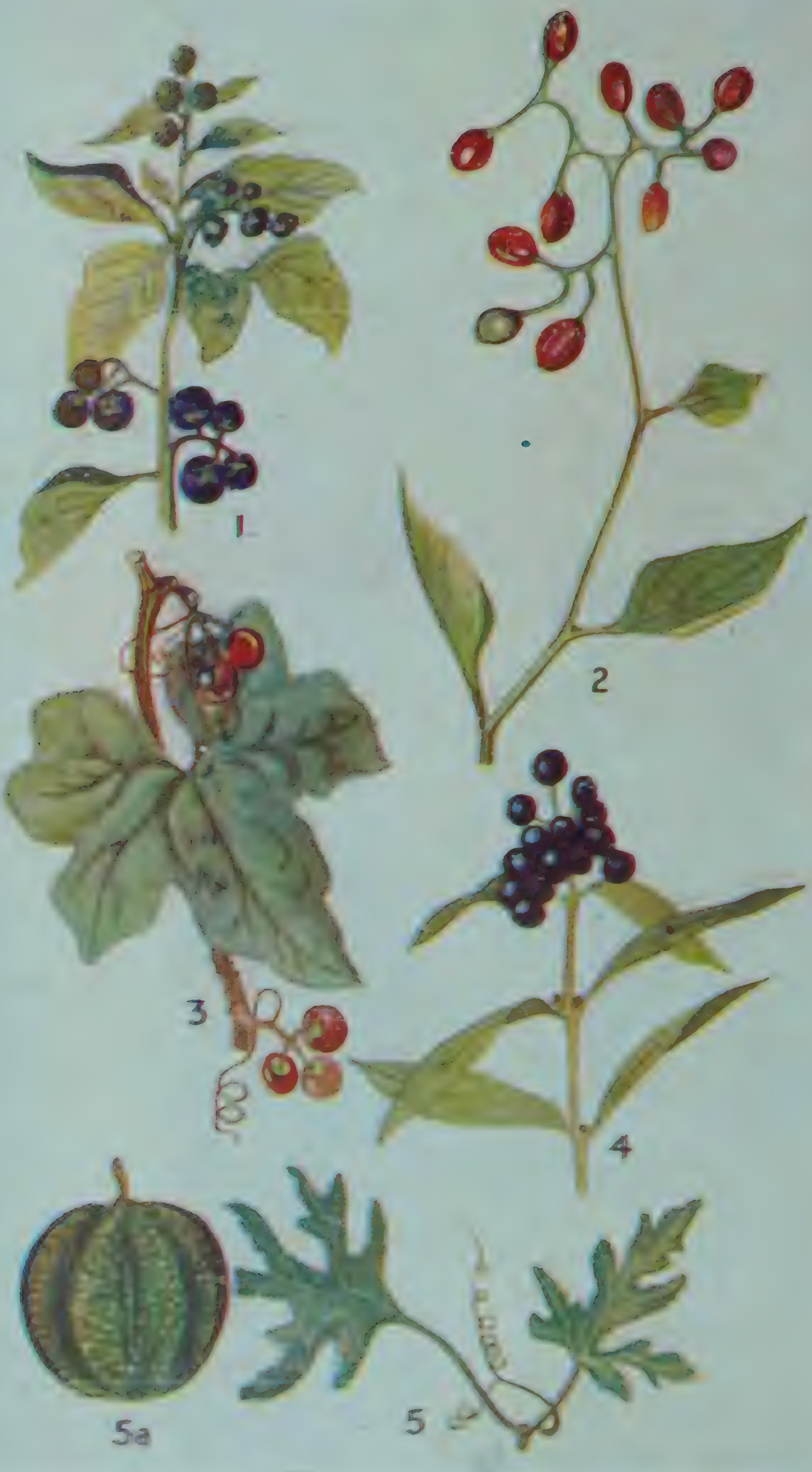


Plate III.

1, Solanum nigrum (black nightshade). 2, Solanum dulcamara (bitter-sweet). 3, Bryonia dioica (common bryony). 4, Ligustrum vulgare (privet). 5A, Citrullus colocynthis (bitter apple: fruit). 5, Citrullus colocynthis (bitter apple: plant).

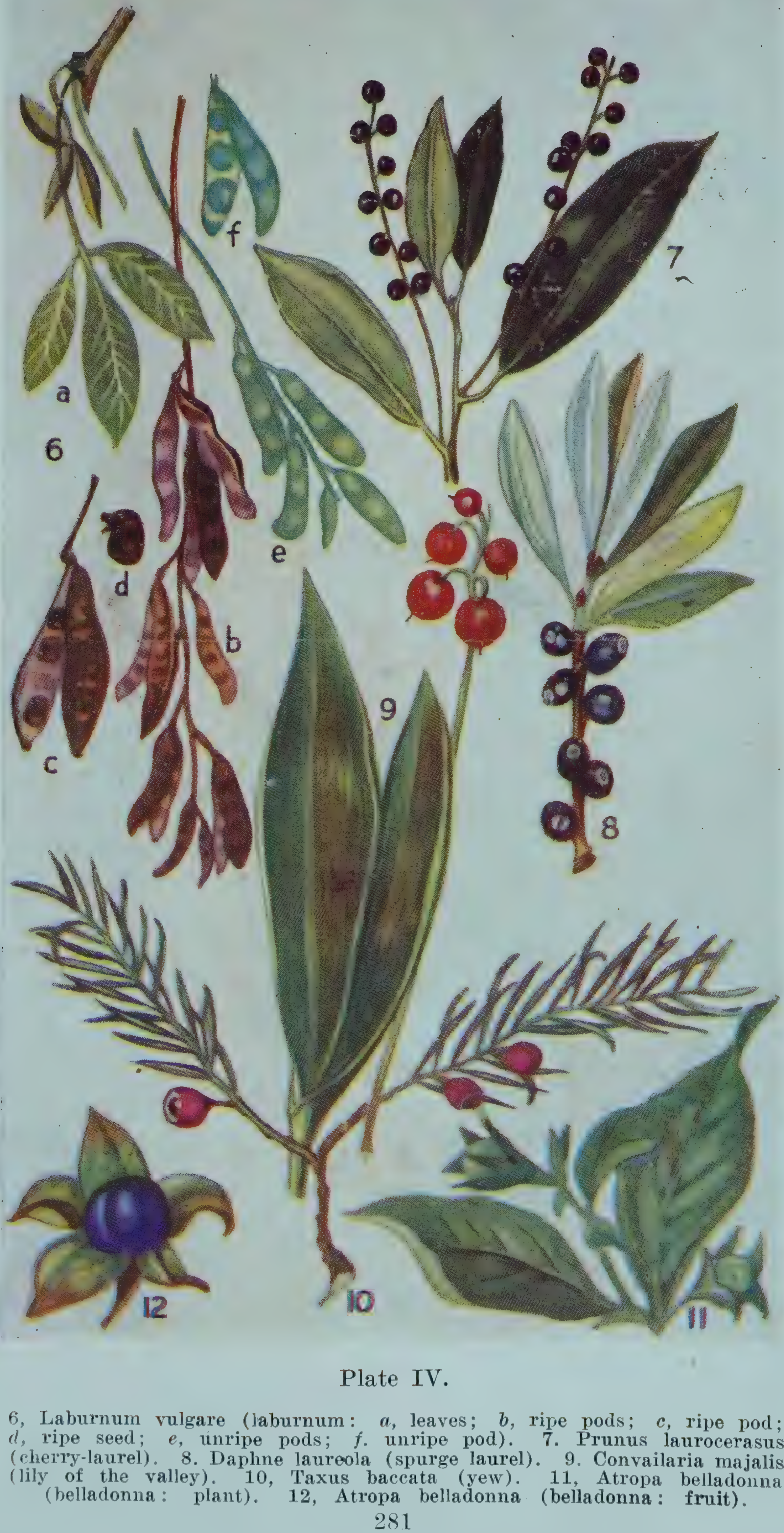


Plate IV.

6, Laburnum vulgare (laburnum: *a*, leaves; *b*, ripe pods; *c*, ripe pod; *d*, ripe seed; *e*, unripe pods; *f*. unripe pod). 7. Prunus laurocerasus (cherry-laurel). 8. Daphne laureola (spurge laurel). 9. Convallaria majalis (lily of the valley). 10, Taxus baccata (yew). 11, Atropa belladonna (belladonna: plant). 12, Atropa belladonna (belladonna: fruit).

some loss of life in England by oxalic acid poisoning. When America joined in the War rhubarb leaves were again responsible for some deaths.

Lathyrism is a spastic paraplegia occasioned in India and elsewhere by the incorporation in bread of *Lathyrus sativus* and *Lathyrus cicera*, which are species of the everlasting pea or bitter vetch. The condition is prevalent especially in times of food shortage, and it has been suggested that the toxic action is not specific to the vetch species but is similar to that exerted by the germs of wheat and rye and is likewise held in check by vitamin A. Hence the emergence of lathyrism in times of scarcity when vitamin A is lacking.

Favism is the anaemic condition, attended by pyrexia, jaundice and haemoglobinuria, which occurs in Italy and has been ascribed to the consumption of beans.

The indications of honey poisoning are vomiting and purging with delirium, prostration and mental disturbance, which may amount to transient mania. There is evidence that the toxic substance is derived by the bees from the blooms of the azalea, oleander and rhododendron. Cases occur in the United States, Brazil and elsewhere and appear to be frequent round the Black Sea. Xenophon tells how his Greeks, when they came to Trebizond, plundered the beehives of the people and feasted on the honey. The symptoms noted above were soon apparent and, with the men lying all about, the scene, he says, was like a battlefield. Some of the looters were sharply ill but all were fit for duty again in 3 or 4 days. This was in the year 400 B.C. Trebizond honey, it is understood, can still cause illness. In the Caucasus today people avoid honey stored when the azalea is in flower. Some of the commoner poisonous plants of Britain are illustrated in Plates III. and IV.

Animal Sources

Poisoning through eating fish has a seasonal prevalence in the tropics. It is familiar in Japan and certain islands of the West Indies. The *Tetrodontidae* or globe fishes, which include the Japanese fish fugu, have been incriminated. The symptoms are choleraic or paralytic and fatal cases are not infrequent. The roe of the pike and the muscle of the sturgeon are poisonous at spawning time. Of natural fish poisoning it may be said that its incidence is capricious and its aetiology obscure.

The Haff sickness, of which a good deal was heard at the time, was contracted from fish caught in the Frisches Haff near Danzig. The poisonous character of the fish was attributed in the end to the trade waste discharged into the waters of the Haff from paper-pulp mills.

Poisoning has been reported also from eating turtle flesh. Mytilotoxin, the mussel poison, has been noted above.

Metals

Apples sprayed on the tree with Paris green, or aceto-arsenite of copper, as an insecticide have been found to carry traces of arsenic when they reach consumers. This is most likely to occur when caseinates have been applied to the fruit to make the poison stick. Wine derived from grapes treated with arsenicals has given rise to poisoning. In the arsenical poisoning of children by boiled sweets at Stoke-on-Trent and Congleton in 1930, the sweets had been dusted with pure arsenious oxide. The poison, being in the solid state, was promptly ejected before absorption and no deaths occurred. In an outbreak lately reported from a Scottish county there were 115 cases of illness with 2 deaths, due to the consumption of sausages containing large amounts of arsenious oxide of unknown origin. Arsenical poisoning is referred to also in the paragraph on beer.

Antimony trioxide, Sb_2O_3, was the cause in England lately of several outbreaks of illness with vomiting among persons who had drunk lemonade prepared in enamelled iron jugs or pails not intended for use with food or drink. In such ware Sb_2O_3 is employed as a cheap opacifying agent, and the enamel itself for the sake of cheapness is soft with a low silica content. The antimony was dissolved out of the soft enamel into the beverage in one instance by the tartaric acid of a synthetic lemonade and in the others by the citric acid of fresh lemons.

Lead poisoning from cider, owing to lead in the cider presses, occurred in Devonshire in the eighteenth century. In 1932 in that county cider took up lead from pipes conveying it to a drinking bar. Savage has recorded lead poisoning from cooking cranberry tart in a lead-glazed earthenware pot. Lead from lead arsenate sprayed on fruit may reach the consumer. R. A. Kehoe found the quantity on apples to be 0·3 mg. per kilo. He states that the average American ingests 0·2 to 0·3 mg. of lead in his food daily and excretes approximately the same amount, there being no cumulative retention of the lead in the body. Recently in this country acute plumbism occurred in a child of 22 months who had drunk orange juice out of toy dishes made of a lead alloy.

There is little risk of poisoning from copper or tin in food. Zinc too under ordinary conditions must be accounted blameless. On a somewhat exceptional occasion, which one of us witnessed during the First World War, apple rings had been provided for the dinner of soldiers in barracks and had been cooked for several hours by simmering over a fire in a galvanised iron foot-bath. Every man who took apple rings was actively sick. An ordinary helping of the rings had contained an emetic dose of zinc, as was shown by subsequent analysis of the apple residues in the bath.

Several cases of poisoning due to cadmium deriving from the metal shelving of refrigerators in which food had been stored have recently been reported.

Aluminium, the last metal to which reference need be made, has been much discussed in connection with the use of aluminium cooking vessels. It should be noted that the metal is normally present in food, the average individual intake from this source daily ranging up to 20 mg. A neutral food cooked in aluminium would add little to this figure. An acid or alkaline food, which would react with the metal, could raise it to 50 mg. or in an extreme case to near 100 mg. It is however known by experiment that 200 mg. of aluminium daily can be taken with impunity for substantial periods. In an official paper the statement is made that there is no convincing evidence that the use of aluminium cooking vessels has a harmful effect upon the ordinary consumer.

Chemical Poisons

The so-called ginger paralysis prevailed in the United States in 1930-31, during the prohibition era, owing to the use as a beverage of the U.S.P. fluid extract of ginger, which had been adulterated with tri-*o*-cresyl phosphate. The adulterant owing to its burning taste gave the ginger effect. The lesion which it produced involved the cervical and lumbar neurons of the cord, causing bi-lateral foot- and wrist-drop.

The employment for table ware in New York and New Jersey hotels of a silver polish containing 20 per cent. of sodium cyanide caused vomiting, cramps and diarrhoea in guests, until the nature of the preparation was realised and its use discontinued.

Instances of illness caused in patrons of restaurants through the careless disposal of chemical substances are from time to time encountered. Thus, in one case, sodium fluoride intended for use as a cockroach repellent was mistaken for flour, while in other premises, a tin of pickling salt containing more than 90 per cent. of sodium nitrite was inadvertently filled into dredgers for table use. Several partakers of the salt were sharply ill. It has been suggested that all such poisonous substances should be tinted, to prevent their being mistaken for edible commodities.

The fumigation with hydrocyanic acid of the holds of ships for the destruction of rats in the presence of food cargoes, and the treatment with ethylene glycol or di-ethylene dioxide of foodstuffs themselves in stores and warehouses in order to free them of insect and other pests, have raised the question whether such fumigation involves risk to persons who may in due course consume the food. The official view is that, provided due care is taken not to overdose the food at the time of exposure and to ventilate it adequately afterwards, no serious risk to health is likely to be involved.

Allergy

In the types of food poisoning such as have been described the food is abnormal while the victim is presumed to be normal. In cases of food allergy the food is normal but the sufferer is presumed to be abnormal. Symptoms pointing to food allergy may be evoked by a range of foods which are perfectly bland to the ordinary consumer. Such are cow's milk, egg white, shell fish, cereals, potatoes, strawberries, oranges and tomatoes. Among the indications of allergy are headache, rash, vomiting, abdominal pain, diarrhoea, and in some cases collapse, symptoms which are frequently present in attacks of bacterial food poisoning also. Where the diagnosis is in doubt, multiple attacks in the same consumer over a period of time would favour allergy. So also would an isolated attack in one consumer while other consumers of the same food were unaffected. In some cases the diagnosis of allergy may be confirmed by skin tests with extracts of the suspect food.

Bacterial Food Poisoning

The symptoms of this disease condition are gastro-intestinal. The attack begins with vomiting, severe diarrhoea and abdominal pain, which are followed by cramps, toxaemia, prostration and, it may be, collapse. The infectivity rate among those who partake of the food is from 50 to 100 per cent.: from person to person it is nil. The case mortality is low, the average for known cases being 1·5 per cent. In fatal cases, which are generally due to ingestion of the living bacillus, the gastro-intestinal mucosa, the spleen and the liver are congested, and the kidneys show cloudy swelling. The infective food material is often meat or prepared meat food, including canned meat: sometimes fish, milk, confectionery, ice-cream, eggs, especially duck eggs, and similar articles.

Most, though not all, outbreaks of bacterial food poisoning are due to bacilli of the Salmonella group, most frequently *B. aertryck*, the Stanley and Reading strains, *B. enteritidis* of Gärtner, Dublin strain, and *B. suipestifer*, European type. Other seizures have been ascribed to haemolytic streptococci and staphylococci. In a substantial number of cases no causative organism has been identified.

The latent period of the infection tends to be short, ranging from an hour or two up to several days. A latent period of a few hours points to the presence of preformed toxin, which is more resistant to heat than the bacillus and may survive in the food alone. A longer latent period represents the time required for the proliferation of the bacillus and the liberation of new-formed toxin. In certain cases the illness at first may present the typical characters of bacterial food poisoning and may later run a chronic course.

B. aertryck and *B. enteritidis* can set up disease in meat animals, and meat from animals so stricken is a usual cause of bacterial poisoning in man where meat foods are in question. The milk of the sick animals may be dangerous also, as in a Glasgow milk-borne outbreak which was traced to a cow with aertryck disease and another at Aberdeen where the cow had enteritidis infection. Where meat is not in question, as for example with cream confectionery, the ingredients of the food, or the food itself after making up, may be infected by rats or mice, among the former of which enteritidis disease is enzootic, and among the latter aertryck disease.

In a proportion of human cases no pathogenic bacteria are demonstrable in the suspect foodstuff and it is now believed that gastro-enterotoxic substances or 'taints' may be generated in food by organisms which are not normally associated with illness.

When an outbreak of bacterial food poisoning occurs the medical practitioner is often the first person to come on the scene. In England and Wales, if he suspects food poisoning, it is his duty under the Food and Drugs Act, 1938, to notify the medical officer of health of the area. In similar case elsewhere in Britain it is advisable that the practitioner should inform the medical officer in order that all necessary steps may be taken without delay. He should himself prevent the destruction or further destruction of any of the suspected food, and should try to recover for examination by a bacteriologist samples from what may happen to be left of a patient's 'helping' and specimens of faeces and vomited matter. The food, even though highly infective, may be perfectly normal in appearance, taste and odour.

The competent inspection and cleanly handling of carcases in slaughter houses, the supervision of the preparation of made-up meat foods and the complete separation of slaughter houses from places in which such foods are prepared are prophylactic of bacterial meat poisoning. With a view to the prevention of bacterial poisoning by such foods as cream confectionery and ice-cream there should be regular supervision of premises where they are made.

Botulism

This infection occurs in Belgium, Germany and Russia. It is endemic in parts of the United States. In Britain it is a rarity. In 1922 an outbreak took place at Loch Maree in Ross-shire. Of eight persons there who partook of sandwiches made with wild duck potted paste, all died within 6 days. More recently a few possible cases have been reported from England. The foodstuffs associated with botulism infection are mainly prepared and preserved foods, often meat and meat products, and in the United States home-canned vegetables and fruit. The morbidity rate among partakers may be 100 per cent. The case mortality runs from 60 to 70 per cent. and on occasion may reach 100 per cent.

The attack of botulism may be ushered in by gastro-intestinal symptoms. The syndrome of the disease proper is a progressive paralysis, believed to be of peripheral origin. Its early manifestations are diplopia, paralysis of accommodation, mydriasis, ptosis and nystagmus. As the mischief extends aphonia may develop, or prolapse of the tongue and paralysis of deglutition. The saliva, sweat and tears are dried up and oliguria has been noted. Consciousness persists to the end. In the fatal cases death appears to result from implication of the respiratory centre. The latent period is usually less than 48 hours and may be as short as 4.

The nerve lesions are produced by the exotoxin of *B. botulinus*, which is a spore-forming obligate anaerobe. Four types of the organism are recognised but only those lettered A and B cause disease in man. The spores, which are widely distributed in soils, including that of Britain, gain access to food in the course of its preparation. The proliferating bacilli elaborate their exotoxin, which thus exists preformed in infective foods at the time of consumption. The poison is of exceptional potency. One patient in America died after nibbling at a pod of spoiled string beans. One of the fatal cases at Loch Maree only bit off a piece of sandwich and immediately spat it out. Though B. botulinus may be recovered from the viscera in fatal cases the disease in man is essentially an intoxication and not a bacillary invasion of the tissues.

While the spores of *B. botulinus* can resist boiling for more than an hour, the toxin is destroyed by exposure to 80° C. for 5 minutes. Thorough cooking is therefore a safeguard. To exclude the bacillus or its spores from access to food, clean methods of preparation suffice, if up to an adequate standard. Pickling meat in 25 per cent. brine is said to have a protective value. Botulinus antitoxin has been made available in this country at selected centres. It is narrowly type-specific.

The poisonous food in botulism is more apt to appear tainted than in bacterial food poisoning. A butyric odour should arouse suspicion of the growth of *B. botulinus*. In dealing with a case the practitioner should try to secure what is left of the suspected food for examination by a bacteriologist, who may find it difficult to isolate the bacillus but may be able to produce typical paralysis in an animal with a filtrate of the food. In England and Wales the practitioner has the duty to notify suspected botulism also to the medical officer. Elsewhere in Britain if he informs the medical officer it will be to the advantage of all concerned.

Inspection of Premises where Food is Prepared or Stored

It is the duty of the Sanitary Inspector to make careful inspection of all premises in his area where food is prepared or stored, bearing in mind that such premises should satisfy the following requirements:

Floors, walls and ceilings should be of impervious material and easily cleansed:

The walls, floor, doors, windows and ceiling of the apartment must be clean:

There must be no sanitary convenience, dustbin or ashpit within or in direct communication with such premises, or so situated that offensive odours or insect pests can penetrate into the room:

The water supply should be direct from the public mains but, if from a storage cistern, then the latter must not directly serve a sanitary convenience:

No drain should be ventilated into the premises, and drainage outlets should be outside of the building, discharging over an approved trap:

The apartment must not be used as a sleeping place or living-room, and must not be in direct communication with such:

The premises should be well lighted, both naturally and artificially, and have adequate means of ventilation:

Food waste or refuse should be removed as quickly as possible, and kept in metal bins or containers with tight-fitting lids until final disposal from the premises:

It is essential that all foods in the course of preparation or in storage should be protected against flies and rodents. This may often be a yard-stick to measure the hygienic standard of the business.

Workers must be clean in person and habit. Proper ablution facilities, such as soap, hot and cold water, and towels, should be provided conveniently for the use of the workers: and

All utensils and apparatus should be thoroughly cleansed after use and carefully stored.

Food Shops

The following are the corresponding requirements for Food Shops:

As far as practicable, food for human consumption should not be exposed for public sale on uncovered counters or benches.

An attractive front shop does not necessarily imply the same state in the portions screened from the public gaze. All such portions therefore should be seen and inspected.

Rats and mice infest many food shops. Their presence is not easily concealed. Examine the junction of the walls with the floor, particularly at or near the water supply and sink.

The refrigerator or cold store in a food shop retailing meat or fish should be inspected as to cleanliness and signs of the presence of vermin sought. Too many flies should prompt a careful scrutiny and a close questioning of the methods employed by the shopkeeper and his assistants, and should call for the fitting of close-mesh metal gauze screens on all window and ventilator openings.

Food wrappings must be properly stored and used. Assistants should not lick their fingers when lifting food wrappings or blow into them.

Premises should not be overstocked to such an extent as to hinder efficient handling and inspection of foodstuffs and cleansing of the premises. Wet cleansing should be the rule, not dry sweeping with its attendant dust nuisance.

The necessity for demanding a high standard of personal hygiene from all food shop workers cannot be overstressed. Domestic animals should not be allowed in food shops, and it should be an offence to expose unprotected foodstuffs outside shops.

X.

VENTILATION

THE atmosphere is a mechanical mixture of gases, not a chemical compound. The relative proportions of the constituent gases vary little at accessible levels, since winds and convectional currents mix the air and diffusion is constantly taking place. Normal dry air at the earth's surface has the following percentage composition by volume at 0° C.:

	Volume Per Cent.
Nitrogen	78·03
Oxygen	20·99
Argon	0·94
Carbon Dioxide	0·03
Neon, Hydrogen, Helium	0·01

In populous places, as a result of the combustion of coal, the carbon dioxide percentage may be 0·04 or over. As altitude increases the heavier constituents of the air gradually diminish and disappear. It has been surmised that at an elevation of about 100 miles what atmosphere there is consists of hydrogen or helium only.

The natural organic particles of the air include spores of plants, moulds and sundry non-pathogenic bacteria. The bacteria at the top of the Clock Tower at Westminster were found to be one third of the number at ground level. The inorganic particles consist of dust raised by the wind or resulting from meteors or thrown out by volcanoes or, near the sea, of salt crystals left suspended by the evaporation of spindrift. Even in mid-ocean the inorganic particles may amount to 500 per cubic centimetre.

Pathogenic organisms such as *B. tuberculosis* have been recovered in the immediate neighbourhood of the sick, usually borne by secretion droplets, and the spores of *B. anthracis* have been recovered from the air of wool-combing premises. Speaking generally, the chemical impurities of air are more significant than its microbic content.

Hygienic ventilation is the art of managing the air in buildings in such a manner as to promote the health and comfort of the people in them. In the open there is usually little need for management. The winds, which are never still for long, provide supplies of fresh air. Indoors, on the other hand, it is common experience that when people are crowded together the air which surrounds them, though fresh at first, begins after a time to undergo vitiation. It conveys a sense of discomfort, with flushing and hotness of the cheeks, which may lead on to headache, sweating, nausea and collapse. The headache is due to turgidity of the Schneiderian membrane and occlusion of the orifices of the sinuses which open into the nasal fossae. The greater the aggregation and the more enclosed the space, the more rapidly do these symptoms supervene. Under extreme conditions death has resulted, as in the following tragic instances:

In 1756, on a night of fervent heat, Suraj-ud-Daulah, the Nawab of Bengal, thrust 146 civilian English into a cell in Fort William, Calcutta. It was a room 18 feet square with two small barred windows on one side. The door was closed on the prisoners at 8 P.M. When it was opened at 6.20 on the following morning 123 were dead.

In 1805, after the Battle of Austerlitz, 300 of the 600 Austrian prisoners were confined in a small cellar, where 260 died in a few hours.

In 1848 the steamer *Londonderry*, with passengers mostly emigrants, ran into rough winter weather between Sligo and Liverpool. Her 200 steerage passengers were shut into their cabin, which was 18 feet long by 11 feet broad by 7 feet high. The hatches were battened down and covered with tarpaulin. When a man broke out and called the first officer 72 were dead and many dying.

VITIATED AIR

These effects of vitiated air were at first ascribed to an organic poison exhaled in the breath, which is now discredited. Later they were attributed to a decrease in the oxygen content of the air brought about by respiration. Such a decrease does occur but its amount is negligible. The fall of oxygen in the stuffiest assembly seldom exceeds 1 per cent., while men in submarines are able to bear a reduction of over 10 per cent. According to a third view which was formerly held the discomfort experienced was occasioned by excess carbon dioxide of respiratory origin. The normal proportion of this gas in town air is 0·04 per cent. Even under the worst conditions in halls and other places of public meeting it seldom rises to 0·5 per cent., and almost never to 1 per cent. Yet it is known that at 3 per cent. respiration is merely deepened, and also that men in breweries have worked for years in concentrations of 1 and 2 per cent. and been none the worse.

The causes actually operative were made plain by Sir L. Hill who shut several students into an air-tight chamber of 3 cubic metres capacity. The CO_2 content rose to 4 per cent., the wet bulb temperature went up to 85° F. and the oxygen fell to 16 per cent. When the subjects signalled distress, electric fans in the chamber were brought into action. Without any addition of oxygen or abstraction of CO_2 their hot discomfort was at once relieved when the fan-driven air, sweeping through their clothing, evaporated moisture from their skins. The latent heat of vaporisation was withdrawn from their bodies, which were refreshed by the coolness so produced.

The right air for comfort is one which is cool enough and dry enough and sufficiently in movement to be able to promote adequate heat loss.

KATATHERMOMETER

The cooling power of the air at or near body temperature may be expressed in terms of the rate of heat loss of the katathermometer. This instrument (Fig. 58), as devised by L. Hill, is an alcohol thermometer with a cylindrical lower expansion 4 cm. long and a smaller expansion at the top. Two marks are cut on its stem, the upper at 100° F. which is above mean body temperature, and the lower at 95° F. which is below the same. The total heat loss of the katathermometer in millicalories, as the alcohol falls from the upper to the lower mark, divided by the total area of the instrument in square centimetres, gives the unit heat loss or factor *f*, which is a constant for each instrument and is cut on its stem. Thus *f* 465 means a heat loss of 465 millicalories per square centimetre.

In order to determine the rate of heat loss in a given case we note the time which the alcohol takes to sink from the upper to the lower mark. The instrument is set by keeping its lower expansion immersed in water about 80° C. till the alcohol enters, but does not fill, the upper expansion. It is then wiped dry, hung in the air which is to be tested, and the time t of falling from the upper to the lower mark recorded in seconds. If $t = 77$ and $f = 465$, f/t is equal to 6, being the rate of heat loss of the katathermometer in millicalories per square centimetre per second at the time and place of observation.

With the instrument dry, the rate is the dry kata rate, written DK. It is the indicator of cooling by radiation and convection. It has been ascertained that the dry kata cools four times as fast as the clothed body of man. Since therefore the heat production in sedentary work is balanced by a heat loss from the body surface of 1.5 millicalories per square centimetre per second, the dry kata rate for sedentary work should be $1.5 \times 4 = \text{DK } 6$. A high DK means great cooling power and a low DK the reverse. For work requiring a heat loss of 2.79 millicalories DK 11 would be right. At DK 5 the room would be too hot and at DK 18 too cold.

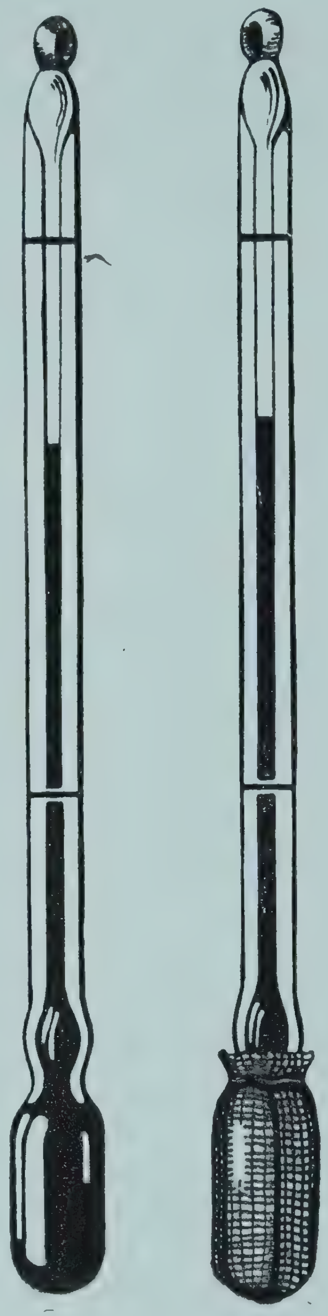


Fig. 58.—Katathermometer, Dry and Wet.

DK 6, the rate for sedentary work, is taken as applicable to ordinary living conditions in houses. It stands for comfort in the home, along with a room temperature round 65° F.

Wet kata rates, written WK, are obtained by covering the lower expansion of the katathermometer with a lisle thread glove finger and leaving it wet after the immersion in hot water. WK denotes the combined cooling effect of radiation, convection and evaporation. The cooling effect of evaporation alone is given by WK − DK. At mean temperatures and humidities the wet katathermometer cools three times as fast as the dry, so that $\text{WK} = \text{DK} \times 3$.

For the air conditions suited to heavy work the wet kata—not the dry—is the better guide. Investigating the working environment of coal miners, Vernon and Bedford brought out a clear relationship between rate of production and the WK reading.

The tests employed were a rest pause test and a tub filling test. Rest pauses are the short voluntary rests from work which men engaged in heavy industries take every few minutes. Tubs are the vehicles in which hewn coal is removed from the working face. The results of the observations made are summarised in the subjoined Table:

Table 31.

Working Capacity Based on Voluntary Rests

Mean WK Cooling Power.	Rest Pauses in Minutes Per Hour.	Tub Filling Time in Minutes.	Percentage Rate of Production.
18·6	4·6	8·0	100
14·6	5·1	8·6	92
12·9	5·7	8·5	92
10·8	5·5	9·2	85
9·0	7.8	9·1	83
6·4	10·6	9·6	74

As the wet kata declined, the rests from hewing grew more frequent and the tubs took longer to fill. So the rate of production fell off. It appeared too that the speed of the air in airways, although a factor in the WK reading, had a separate special influence on cooling power and therefore on rate of production. In two groups of men working at the same WK reading, but at mean air velocities of 15 and 51 feet per minute respectively, for the low velocity group the rest pauses were 9·6 minutes per hour and the tub filling time 9 minutes. For the high velocity group the corresponding figures were 7·8 and 8·6. Even the WK reading therefore may not tell the whole tale.

While the ordinary katathermometer has been found sufficiently accurate for most practical purposes, it does not respond to all environmental influences in quite the same way as the body of man. For more precise determinations other instruments are employed. Thus the 'silvered katathermometer' can discount the effect of radiant energy, while the 'globe thermometer,' which is an ordinary thermometer enclosed in a black-painted hollow copper sphere, recognises the warming value of a source of radiant heat. The 'eupatheoscope' is a thermometer bulb inside a black-painted hollow copper cylinder which is maintained by a thermostat at 75° F. The readings of the eupatheoscope thermometer, which are called 'equivalent temperatures,' represent the combined influences of convection and radiation as they affect the body. The 'effective temperature' as used at Pittsburg gives air movement, temperature and humidity by means of a single temperature index, for example 66° F., which is the optimum for persons normally clothed and slightly active. It does not take account of radiation.

With hard work at high temperatures no cooling may be possible by radiation or convection, so that comfort and efficiency may come to depend entirely upon the withdrawal of heat from the body as a result of the evaporation of sweat from the skin. Under such conditions WK.

which takes account of evaporation, is the significant figure. For the same reason the critical temperature for work in still air is given as 78° F. of the wet bulb mercurial thermometer, not of the dry.

In L. Hill's experiments the wet bulb thermometer was allowed to rise to 85° F.: immediate relief was then given by fanning the air. The question of the endurable limits of high temperature in which men can continue to live or work was investigated by J. S. Haldane in the Dolcoath Mine and elsewhere. He found that during rest in still air the rectal temperature showed no abnormal increase up to 88° F. wet bulb. At 90° W.B. it rose 1° F. per hour, at 94° W.B. 2° F. per hour, and at 98° W.B. 4° F. per hour. Under such conditions heat stroke was impending. In an air current of 170 linear feet per minute, 93° W.B. could be borne.

During muscular work in still air the endurable wet bulb limit was 78° F., 10° lower than during rest. At 87° W.B. the rectal temperature rose 3·5° F. per hour. In an air current of 135 linear feet per minute, 85° W.B. could be borne, but not 87°.

The symptoms accompanying the rise of body temperature were increase in the pulse rate with throbbing in the head, dyspnoea, especially on exertion, and a general feeling of exhaustion and malaise. The increase of pulse rate was 20 beats per minute per degree F. of rise of rectal temperature. Hyperpnoea was marked at 103° F. rectal temperature, during both rest and exertion. Acclimatisation appeared to play some part in mitigating certain of these distresses.

The discomforts entailed had no relation to the dry bulb readings. Whether the dry bulb was the same as the wet bulb or 10° F. above it, or 50° F. above it, the rise of rectal temperature was found to be conditioned by the wet bulb readings alone.

AIR DELIVERY

The best air for comfort indoors is that which has the qualities represented by DK 6. When the air in a room is beginning to feel oppressive, with a DK reading below 6 or thereby, it may be found on chemical examination that its CO_2 content has risen from the normal 0·04 to 0·07 per cent. or over. The increase of CO_2, as shown above, in no way produces the symptoms of discomfort, but if the discomfort is due to the presence of people and not to concurrent unrelated causes, the rise of CO_2 which attends it corresponds approximately to its degree. This figure 0·07, at which the air is thought to require renewal, is the permissible limit of CO_2. Therefore $0{\cdot}07 - 0{\cdot}04 = 0{\cdot}03$ per cent. is the permissible added CO_2, equivalent to 0·0003 cubic foot of respiratory CO_2 per cubic foot of air. In the ordinary room the easiest way to maintain the standard is to replace the indoor air, as it grows moist and warm, by fresh air from the outside. This fresh air, being cooler than the air in the room, may be felt as a draught at its point of entry and so cause discomfort. The avoidance of the draught effect is a main consideration of air delivery in this country. The other factors are the number of people in the room and its cubic content.

We may take as a simple example a room occupied by two persons. In terms of the Housing Act, 1936, such a room should have a floor area of 110 square feet. With a height from floor to ceiling of 9·1 linear feet, the cubic content of the room works out at 1001 cubic feet. A fresh air supply of 2000 cubic feet per hour, if delivered from the outside into a room of these dimensions through a suitable inlet, would enter the room with a velocity of 2 feet per second. If the outside air is at an ordinary temperature, say 60° F., the stream entering at this speed would not be felt as a draught by the people in the room. If the outside air fell to freezing point the entering stream, being cold and dense, would carry further out into the room and would be felt. While the cold spell lasted this chill entering air could be warmed by a radiator or directed upwards or baffled with a screen. So far as draughts are concerned the comfort of the two inhabitants of the room is reasonably provided for. As regards the maintenance of their health they would each get a fresh air delivery of 1000 cubic feet per hour, which is an adequate figure. Amounts as low as 600 cubic feet have been approved.

AIR CHANGE

The passing of 2000 cubic feet of air through 1000 cubic feet of space gives two changes of air per hour, which is a rate accepted by most. Some think one change per hour sufficient and some would be content with one change every 2 hours. On the other hand three changes are good and, if the outside air is warm, still more frequent changes may be desirable. In a warship in the tropics at night with an open-air temperature of 81° F. twenty changes of air per hour on the mess deck gave satisfaction to all concerned. The occupant of a cabin against a hot bulkhead on an Atlantic liner enjoyed thirty changes in the hour. Frequent change is in general to be preferred to infrequent change, because it effects a more speedy removal of any spray-borne infection which may have been launched upon the air.

DIMENSIONS

Cubic Content. This Table exemplifies figures approved for various types of buildings.

TABLE 32.

CUBIC FEET OF SPACE PER HEAD

Teaching General Hospital .	1,800	Approved Standard.
Infectious Diseases Hospital .	1,440	Department of Health for Scotland.
Army Hospital Wards . .	1,200	British Army Regulations.
General Hospital . . .	1,200	Approved Standard.
Army Barracks . . .	600	British Army Regulations.
Room for 2 persons . .	500	Housing Act, 1936.
Common Lodging Houses .	300	Ministry of Health.
Sick Bay, R.N. . . .	150	Royal Navy.
Factories	400	Factories Act, 1937.
Mess Deck, R.N. . . .	150	Royal Navy.
Seamen's Cabins . . .	120	Merchant Shipping Act, 1906.
Canal Boats	60	Canal Boats Regulations.

Floor Area. This dimension largely determines the cubic content of rooms. Adequate floor area is necessary in dwellings in order to prevent over-propinquity. Aggregation under crowded living conditions is hurtful to morality, and under any conditions shortens the path of spray-borne infection. For the wards of infectious diseases hospitals 144 square feet per patient is a proper allowance and for general hospitals 100 square feet. For a bedroom intended for one person in an ordinary house 150 square feet is a good measurement, for maids' and nurses' bedrooms in hospitals 100 square feet. For small single bedrooms 65 square feet has been permitted. Thirty square feet per head is approved for working-class living rooms.

Length is of special importance in dormitories and the wards of hospitals, with special reference to the linear distance between the heads of sleepers. This question is discussed below under the title ' propinquity diseases.'

Breadth mainly requires consideration in connection with hospital wards. For a ward of the customary rectangular shape with the beds at right angles to the long sides, the breadth in an ordinary hospital should be 24 linear feet. For a ward in a teaching hospital 26 feet will be required.

Height. Nine feet is an approved height for a ground floor room in a house and 8½ feet for an upper room. In ordinary houses the height of ceilings may range up to 11 feet. For hospital wards the height should be 12 feet or more. Eight feet is too low for a habitable room : such rooms lose light from the sky and are dark in their recesses.

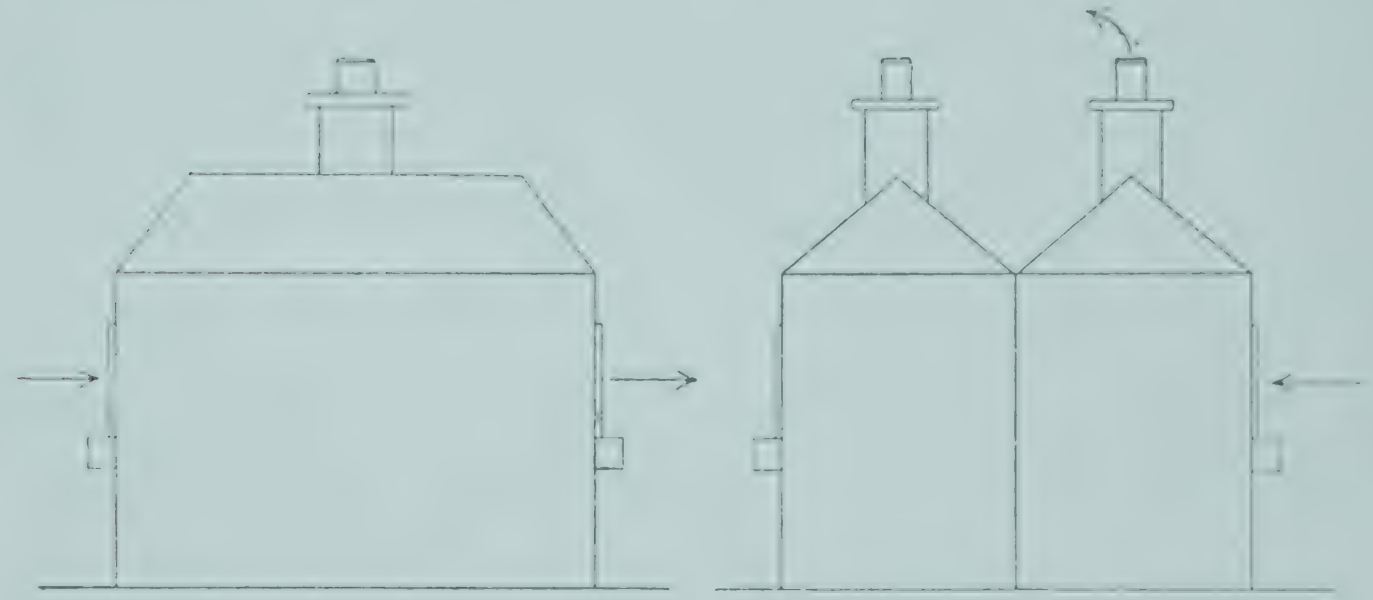
NATURAL VENTILATION

Natural ventilation is the supply of fresh air by means of natural agents. It is best for houses, schools, hospital wards, and inhabited buildings generally. The agents at work are (1) diffusion, (2) wind movement and (3) inequality of temperature. The channels through which they work are (1) existing openings and (2) made channels.

Diffusion. Gases diffuse at a rate which varies inversely as the square root of their densities. Diffusion in houses takes place through the brick and stone work, but too slowly in the case of inhabited rooms to be of much practical importance.

Wind Movement. The winds act by perflation and aspiration. In *perflation* (Fig. 59) they blow through the house or room, entering by a window or other opening on the windward side and escaping by a corresponding exit to leeward. Rooms or houses so constructed as to admit free perflation are said to be cross-ventilated. Back-to-back houses do not admit of perflation, and their erection is forbidden by law, unless in special cases. *Aspiration* occurs when a wind blows across the mouth of a chimney and sucks up air which is then replaced by fresh air coming in from the open. If a habitable room is without a chimney a proper air shaft must be put in. This provision meets the case of rooms in all-electric houses and multi-storey flats.

Inequality of Temperature. The most effective force in natural ventilation is the difference in density between masses of air at unequal temperatures. According to Charles's and Gay-Lussac's law air when heated expands. Expanding, it grows lighter and tends to rise. In any room where a fire is burning there is a heated column of air ascending the chimney. The velocity of the moving column is determined by the difference between its temperature and that of the outside air, together with the height, cross-sectional area and angular deviations of the chimney. Similar considerations apply to inlets for fresh air, or roof exit shafts for warm used air. The theoretical velocity in any of these airways may be worked out, if desired, by Montgolfier's formula and checked by the presumed coefficient of friction, which largely depends upon angular deviations, but the results so obtained are usually found to have little practical significance. The actual velocity may be measured directly with an air meter set in the channel, when the figure recorded on the meter dial multiplied by the cross section of the airway will give the volume of air moving in or out, as the case may be, in a specified time. For low velocities the Katathermometer may be employed according to the formula



Perflation. **Back-to-back Houses.**

Fig. 59.—Natural Ventilation.

$$H/\theta = 0{\cdot}27 + 0{\cdot}49\sqrt{V}$$

where H = heat loss in millicalories per square centimetre per second, $\theta = (36{\cdot}5 - t)$ °C., and V = velocity of the air current in metres per second. The thermal factor in natural ventilation is most active in winter, when the difference between inside and outside temperatures is greatest, and windows are apt to be kept shut to exclude the inclement air. It is thus at its best when most required.

In any room with a fire burning there is a column of heated air continually ascending the chimney, and drawing fresh air into the room. Whether a fire is on or not, if there are people in the room the air which they warm at the breathing level rises up and makes its escape, through windows open at the top or by special exit channels, and is replaced by fresh entering air.

Existing Openings which are used in natural ventilation are principally windows and chimneys. *Windows* should if possible extend up to near the ceiling and should open up to the lintel. One-third of each window, in Scotland one-half, should be made so as to open, and the glazed window area in every habitable room should equal one-tenth of the floor area. A casement window can open fully: a sash window as to one-half of its area only. *Chimneys,* as just noted, exert an exhaust action while the fire is burning and may draw up 20,000 cubic feet of air per hour. After the fire is out, so long as the chimney is warm, the thermal factor continues in operation. When the chimney has cooled, aspiration continues to keep the air in motion, and a similar effect may be produced by means of whirling cowls and other devices. The flues of gas fires have an exhaust value also. In response to these exhausts air enters the room, when door and windows are closed, between the door and its door-posts, between the windows and their frames, between their upper and lower sashes, through flaws in plaster or open joints in woodwork, and to some slight extent through the stone or brick of the outer walls. With many buildings in cold weather these infiltrations are the only sources of fresh air.

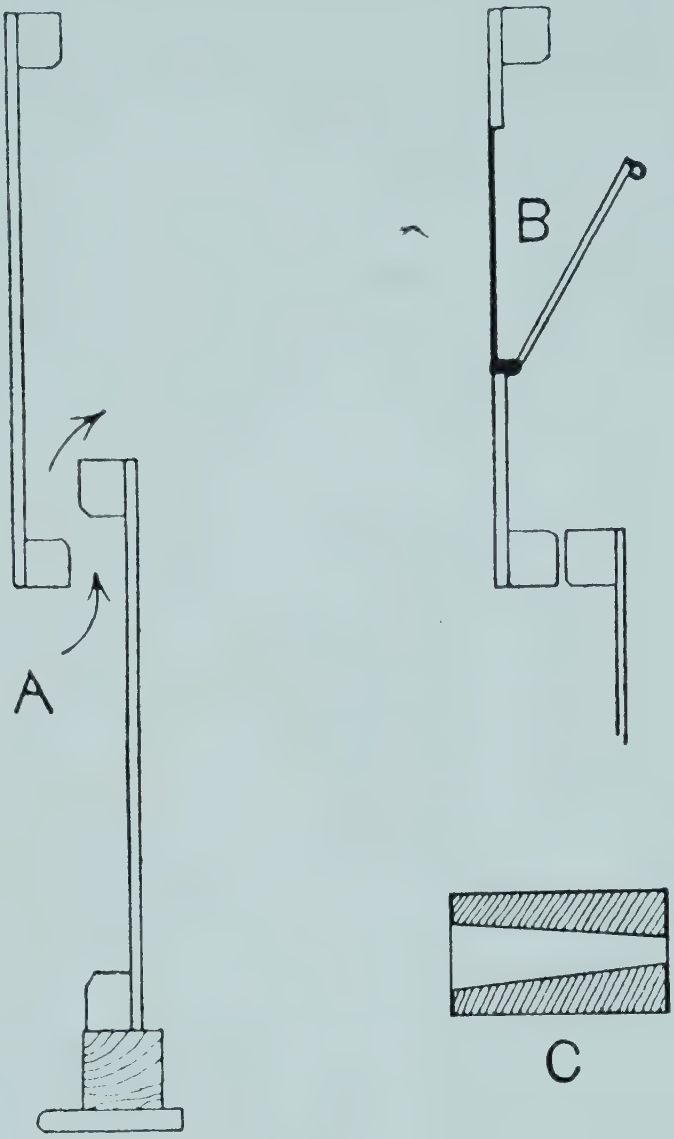


Fig. 60.—Ventilation Inlets.

A. Hinckes Bird Window. B. Hopper Window Inlet. C. Ellison's Conical Brick.

Crowder found that in wooden railway sleeping carriages, closing the roof sashes reduced ventilation from 28,300 to 18,500 cubic feet per hour only. For steel sleeping carriages the corresponding reduction was from 65,950 to 53,000 cubic feet per hour only. So much is achieved in ventilation by unconsidered crannies.

Made Channels for natural ventilation are either inlets or outlets. *Inlets,* if specially provided, should open 5 feet above the floor. Entering air, in order to mitigate draughts, should be directed upwards, as in the Hinckes Bird window (Fig. 60), the louvred pane, the hopper window inlet and the Sheringham wall valve: or divided into several streams as by Cooper's disc: or slowed down by passing through diverging channels as in Ellison's conical bricks for stables, cow-houses and gymnasia. *Outlets* should be short, straight, vertical shafts leading from the ceiling direct to the open. M‘Kinnell's roof ventilator serves both as inlet and outlet. It consists of two tubes, one within the other, the inner being longer and surmounted by a cowl. Fresh air passes downward between the tubes while used air leaves by the central channel (Fig. 61).

All ventilating channels, whether existing or made, are subject to the caprice of the wind. The intended outlet may act as an inlet and *vice versa.* If so, there is usually no harm done. Blow-downs in chimneys are, however, vexatious. They may be prevented by means of a horizontal baffle plate clamped on a few inches above the outlet of the chimney. On ships cowled ventilators turned to meet the wind carry fresh air below: when turned away from the wind they serve as useful exhausts.

ARTIFICIAL VENTILATION

Ventilation is artificial when the air supply is regulated by mechanical power. When the plant is designed to control temperature and humidity as well as air flow, the process is known as air-conditioning. It is best for theatres and public buildings where many people are gathered together for limited periods, and for special rooms in hospitals. In one of its forms it is useful in factories also. The systems of artificial ventilation are (1) Propulsion, (2) Exhaust and (3) Balance.

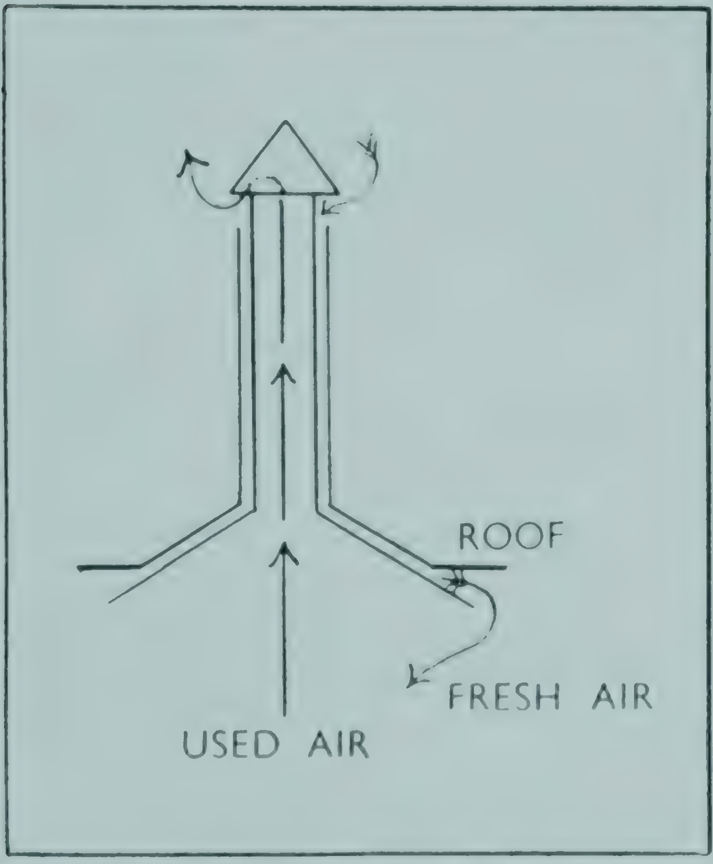


Fig. 61.—McKinnell's Roof Ventilator.

Propulsion. On this system, known also as the *plenum* system, the fresh air is taken in by means of a large electric fan. It is washed in a water screen or filtered through a viscous filter, then warmed or cooled according to the season, and finally humidified, if necessary. So conditioned, it is driven along the main duct and on by branch ducts to the points of delivery. It enters each room by an opening high in the wall, emerges by an exit low down on the same side, whence it is conveyed by an upcast shaft passing through the roof. On this plan the breathing line is almost completely bathed by the incoming air. Alternative positions of the apertures may lead to short-circuiting of the air current, especially when windows are not firmly closed (Fig. 62). The direction of the entering air may be controlled by means of a punkah louvre or other device. Tobacco smoke filters, fog baffles and ozonisers may be incorporated in the plant. Sometimes the entering air is made hot enough to warm the room or hall. On the 'split' system, which is better, it comes in at room temperature and radiators are provided for local warming.

Exhaust. On this system, also worked by means of electric fans, the air is drawn out instead of being driven in. It may be employed to aid the general air movement in factory buildings. It is the method of election for coal mines. It is of use in industry also for the special purpose of providing local exhausts to carry dangerous dusts or fumes away from workrooms or benches.

Balance. This system, which combines both propulsion and extraction, lends itself to accurate adjustments and is now most in favour for large halls of assembly. Air movement with the balance system may be either from above downwards, as in the Houses of Congress at Washington, or from below upwards, as in the House of Commons at Westminster lately and now in the large examination hall at Cambridge. There is no general consensus of opinion as to which is the better direction.

The success of artificial ventilation plant depends to a large extent upon careful planning of the air ducts. These should be streamlined, free from corners and sharp bends and finished internally with a smooth, easily cleansed surface.

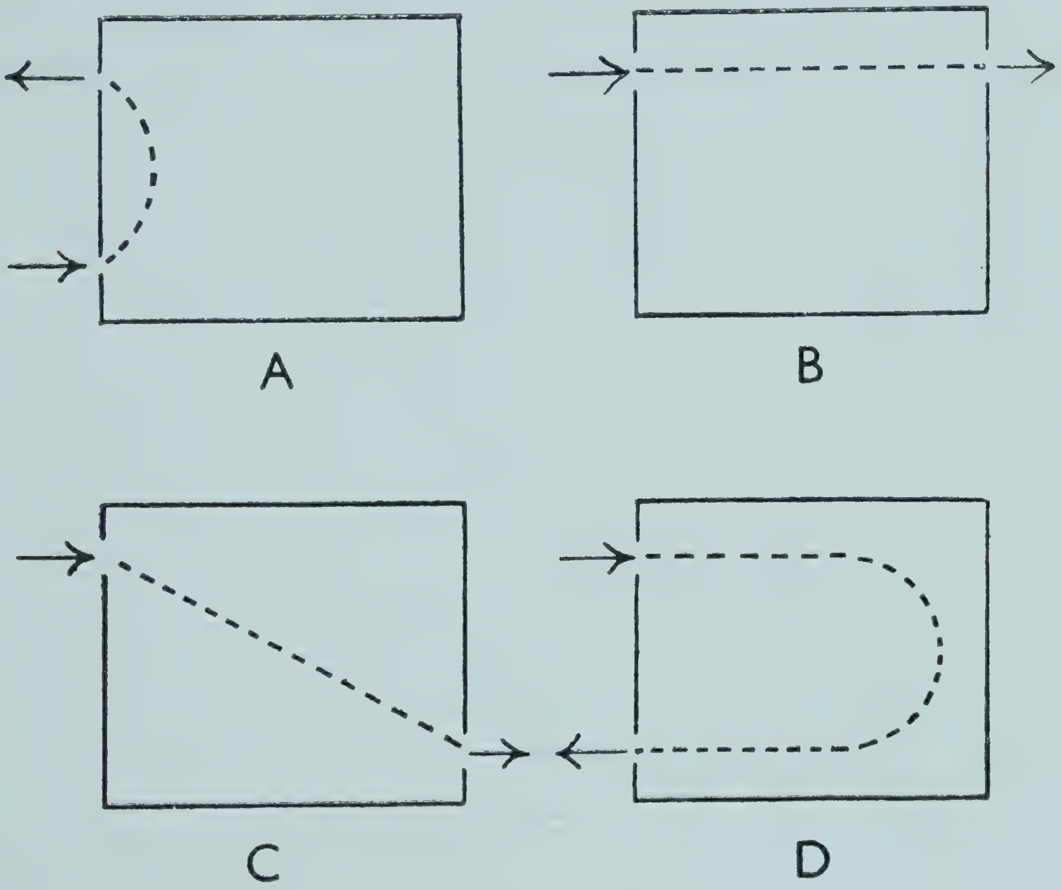


Fig. 62.—Plenum System—placing of ducts.
'D' represents the correct position for inlet and outlet respectively.

AGITATOR FANS

Agitator electric fans do not deliver fresh air, but by setting still air in motion they greatly promote comfort. L. Hill's incarcerated students[1] knew their genial influence. The Indian punkah was their forerunner. They are made either large or small, either fixed or portable and either stationary, swinging or pivoted so as to change direction as they spin. On land in the tropics when the air in the house is too hot and the open air hotter still, it is useless, or worse, to bring the open air in: agitator fans under such conditions can maintain adequate heat loss by promoting evaporation from the skin. At sea in the tropics in an officer's cabin with the dry bulb thermometer at 85° F. and the wet bulb at 79° F. a small table fan, though local in its range, raised the wet kata reading from 7·2 to 23·4.

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[1] Page 290.

TESTING OF VENTILATION

When assessing the efficiency of ventilation in premises, the dimensions of each room should be noted, together with the number of persons normally present, the extent and position of windows and the presence or absence of chimney flues or air shafts. Lighted gas jets and heating devices in operation should be counted. When the room is a sleeping apartment, the inspection should take place early in the morning, preferably before the occupants have arisen. Wet and dry bulb temperatures should be taken and dry kata observations made. Experienced inspectors lay considerable stress upon the sensory impressions received on entering the premises. The carbon dioxide content of the atmosphere in the room may be determined on the spot by means of the Haldane absorption burette, or a sample of air may be drawn and sent to the laboratory. The sample is readily secured by filling a Winchester quart bottle with tap water and emptying it where the sample is to be taken. It should be noted, however, that this method will not serve for precise analyses, since certain of the constituents of the air pass into solution in the residual water. In cases where great accuracy is required, as in testing factory air for traces of noxious gases, several litres of air should be drawn through a dry sampling bottle. When a bacteriological opinion is sought, a known volume of the air should be aspirated through a quantity of sterile distilled water, which should thereafter be plated on media, and the resulting colonies counted. It is then a simple matter to calculate the number of viable bacteria in one cubic metre or cubic foot of air. Data accompanying an air sample to the laboratory should include a description of the premises, the date, place and time of sampling, the system of ventilation in use, the reason for the analysis and any other relevant points.

Examinations of the exhaust ventilation in factories may require an estimate to be made of the dust content in the air of work rooms. This is most conveniently done by means of the Owens jet collector, which causes the air-suspended particles to be deposited upon the surface of a micro coverslip, where they can be enumerated with the aid of a low power lens.

The inspection of air-conditioning plant should include an examination of the ducts, shafts and fan chamber for cleanliness, the observation of air temperature and humidity in the various rooms and the determination of the speed of air flow by means of the velometer or other device.

XI.

WARMING

THE presence of people in rooms raises the temperature of the air, and may suffice in mild weather to keep room temperatures from falling too far below the optimum 65° F. to which reference has been made. In wintry weather, however, when outdoor temperatures are low, houses in this country must be specially warmed if rooms are to be maintained at or near comfort level, say, at a temperature of 60° to 65° F., together with a dry kata reading of 6.

Warming in houses is effected by radiation, convection, conduction or combinations of these. The most agreeable kind of warming is that produced by radiant energy which heats the floor and walls of rooms but leaves the air cool. It has been claimed that the best rays of all are the red and the short infra-red, on either side of 7700 A, which are not arrested by the horny layer of the skin but pass through it and convey the impression of warming the blood. The long dark rays, on the contrary, about 60,000 A, produce a hot surface. They scorch without warming. Hence a flaming fire, which is rich in the red and the short infra-red, has a genial comforting power which is not possessed by a steam or hot-water radiator emitting dark heat waves only. If good radiant sources are available air temperatures lower than 65° F. can easily be borne: 55° F. is however the lowest temperature for efficient manual work in schools.

The chief sources of the heat used in warming are coal burned in an open grate or closed stove, gas, electricity, hot water, steam and hot air.

Coal Fire. The open coal fire heats principally by radiation. The average grate burns 8 lbs. of coal per hour, and may exhaust from a room 10,000 to 20,000 cubic feet of air per hour. Of the possible energy some 25 per cent. becomes directly available for warming. The combustion is irregular, which relieves monotony. When the chimney is built in an inner wall it is claimed that up to 50 per cent. of the heat of combustion can be utilised. The best type of grate has a concave floor of iron fire-bars with narrow intervals. Below the fire-bars is an air space closed by an iron plate or economiser, with adjustable inlet. The grate should have no bars in front. Its sides and back should be of fire-brick, which continues to radiate warmth after the fire itself has gone out. The chimney throat should be narrow and controlled by means of an adjustable metal blower. In the rifle-back grate the back is set at an angle and the sides may be splayed outwards.

The open fire with its penetrating visible rays yields a pleasant warmth without parching the air. At the same time, however, when burning bituminous coal, it contributes to the smoke nuisance of towns. Low temperature carbonisation fuel, such as 'Suncole' and 'Coalite,' which is coal deprived of certain extractives, produces when burned in an open grate a practically smokeless fire. The qualities besides smokelessness which should be possessed by such a fuel, are ease of ignition, low sulphur content, high radiant energy, absence of ash and low cost per unit of heat.

Wood and peat, where available, produce cheerful but short-lived open fires.

Special open grates for burning gas coke are now available. Vertical retort coke, which has not been water-quenched, is said to be best for the purpose.

Stove. The stove, which is a closed combustion chamber, burning bituminous coal or coke, heats by dark radiation and convection. In cold climates the flue is carried round the walls of rooms in order to utilise all possible heat. The exhaust ventilation of the coal stove is slight, so that the air is warmed, and its relative humidity lowered. Hence a feeling of dryness in the air with consequent discomfort, the remedy for which is to open a window. Stoves when allowed to become red hot char the organic content of the air, producing oppressive vapours. To prevent this charring they are lined with fire-brick or covered with tiles. Cast-iron stoves may liberate carbonic oxide from the carbon in their iron. Wrought iron is therefore to be preferred.

Anthracite stoves require little supervision and are nearly smokeless. They are excellent for the halls of houses, but must be gas-tight.

Oil stoves, which may be either of the open or pressure type, burn paraffin in lamps with broad or circular wicks. They are usually flueless and heat by convection, their combustion gases escaping into the room. With inferior oils they may free acrolein or acrylic aldehyde, CH_2: CH. CHO, which has an irritating odour. They are portable and convenient, especially for country houses.

Gas Fire. The gas fire, burning coal gas, consists of a row of Bunsen burners playing on asbestos or fire-clay radiants. It consumes from 10 to 20 cubic feet of gas per hour. Though the combustion is smokeless a flue is necessary. The fire radiates 50 per cent. of the thermal energy of the gas burned and makes a further 10 per cent. available by way of convection and conduction. The remaining 40 per cent. passes up the flue as the motive power of a useful exhaust, the strength of which may be increased by making auxiliary openings into the flue. The exhaust of the gas fire is weaker than that of the coal fire, so that the air of the room unrenewed from the open tends to become hot and dry. When the evaporation of water from a basin set on the gas fire fails, as it usually does, to maintain a comfortable humidity, fresh air can be admitted.

Coal Gas as burned in domestic gas fires in this country results from the destructive distillation of coal at about 1800° F. Emerging from the retorts at 160° F. the gas passes first through an air cooler to remove ammonia, tar and water, and then in succession through a water scrubber, wet washer, and hydrated oxide of iron purifier to complete the separa tion of ammonia and take out H_2S and CO_2. The illuminants in coal gas include C_2H_4, C_2H_2, and C_6H_6: the principal diluents are H_2, CH_4, and CO. These constituents may occur in the following percentages:

Illuminants	5
Hydrogen	50
Methane	25
Carbonic oxide	17
Other gases	3

The products of combustion are nitrogen, water, CO, CO_2, and traces of SO_2, NH_3, and other substances. Escaping coal gas may produce in houses an explosive mixture with air, or cause carbonic oxide poisoning. An escape of coal gas can usually be recognised by its characteristic odour: but gas entering a house from a broken gas main may be deodorised in its passage through the soil. The unit of coal gas for sale purposes is the therm, which is equal to 100,000 B.T.U.

Water Gas is prepared by blowing steam through incandescent gas-coke in a generator. The steam reacts with carbon thus: $C + H_2O = CO + H_2$, carbonic oxide and hydrogen being freed. As the coke cools CO_2 begins to be formed thus: $C + 2H_2O = CO_2 + 2H_2$. After four minutes blowing the generator is reheated and the process started afresh. Water gas may have the following percentage composition:

Hydrogen	50
Carbonic oxide	40
Carbon dioxide	5
Nitrogen	5

The products of combustion are H_2O and CO_2. Water gas is cheaper than coal gas, but owing to its high carbonic oxide content much more poisonous. Being odourless it may escape into the air undetected. It is too dangerous for domestic uses, but renders good service in industry.

Producer Gas is formed in a coke-charged producer containing a revolving grate. In the lower levels of the grate air-blown coke burns to CO_2, which is reduced to CO by the hot coke above. In the reheating of the water gas generator, when the coke is blown with air for ten minutes, producer gas is formed and led away to raise the steam required. Producer gas may have the following percentage composition:

Hydrogen	4
Carbonic oxide	30
Carbon dioxide	4
Nitrogen	62

Producer gas has less than half the calorific value of water gas. Its uses are industrial.

Mond Gas is a mixture of water gas and producer gas formed by blowing a generator with air and steam in suitable proportions.

Gas of the 'calor' type, consisting of the hydrocarbons butane or propane compressed in liquid form in cylinders, can supply light, warmth and facilities for cooking to country houses, caravans and sea craft.

Electricity. The most usual type of high-temperature electric radiator is composed of wire elements of refractory metal, such as nickel-chromium alloy, which are heated to incandescence by the passage of the current. The elements are backed by porcelain, mica or fireclay supports. The warming effect is of an agreeable kind, being produced as to 75 per cent. by radiation and as to 25 per cent. by convection. The efficiency is 100 per cent., the whole of the energy being liberated for use. Where a room has a chimney but the fire is not on, an electric radiator placed in front of the grate is a useful aid to ventilation. Another high-temperature type, for occasional heating, is an incandescent electric lamp inside a parabolic copper or chromium-plated reflector.

In low-temperature electric heating the nickel-chromium wires may be set in plaster of Paris on a cement-asbestos backboard, forming a panel which is embedded in walls or ceilings. 'Electric wallpaper' consists of fine wires in a thin sheet of insulating material which can be stuck on walls with paste. Cast-iron panels containing the heating elements are not intended to be embedded: they can either be recessed in the wall or ceiling or attached to the surface. They are maintained at temperatures up to 125° F. Tubular electric heaters are steel tubes 2 inches in diameter, containing a nickel-chromium wire. They may be fixed at window sills or on skirting boards. They heat mainly by convection.

Hot Water. The method of circulating hot water from a central source to the various parts of a building is called Central Heating. It acts by dark radiation and also by convection. The central source is usually a coke-fired boiler which may be thermostatically controlled. In institutions where steam is available the water may be heated in calorifiers. The water circulates in a closed system of pipes with expansion tank. The heat may be emitted in rooms either direct from the pipes, or radiators may be employed. The radiators, despite their name, operate only 25 per cent. by radiation and the rest by convection. On the *Low Pressure* system, which is used in houses and schools, the temperature of the water is below 212° F., usually about 190° F., and the 3 to 4 inch cast iron pipes are laid along the walls of rooms a foot or two above the floor. They should never be recessed in the floor under gratings. On the *High Pressure* (Fig. 63) system the pipes are of welded wrought iron and $\frac{7}{8}$ inch in diameter. One sixth of the total piping is coiled in the furnace. The temperature of the water may be 300° F., which is hot enough to char the air of rooms. The system is employed mainly in factories, halls of assembly and other public buildings.

On the *Panel* system low-pressure hot water is carried in steel pipes. The $\frac{1}{2}$ inch pipes are embedded in panels of asbestos together with sawdust and cement let into the walls and floor. The system is conducive to comfort, and has been found satisfactory.

On the *Indirect plan*, as employed in houses, there is a primary circulation which provides domestic hot water and an off-shoot secondary circulation which supplies the radiators. In summer the secondary circuit can be disconnected, leaving the hot water supply unaffected.

Hot-water radiators are often placed at windows (Fig. 64) in order to warm fresh entering air and give it an upward direction or, when the window is closed, to catch and reverse descending currents of room air chilled by contact with the glass. Long low wall-type radiators, extending along the whole length of the window sill, have been recommended as best for these purposes. Radiators finished in bronze or aluminium paints are less effective than those which are coloured dark green or maroon.

In low-temperature radiant heating ¾ inch steel pipes carrying low-pressure hot water are embedded in cement-asbestos so as to form panels in walls and ceilings. 'Rayrads,' or exposed panels, are cast-iron plates in which channels are provided to receive the hot water. They can either be recessed in walls or ceilings or fixed on to their surfaces. Under-floor heating by means of 2 inch hot-water pipes, placed 3 inches below floor level, may be arranged on an equivalent plan and will maintain a floor level temperature of 76° F.

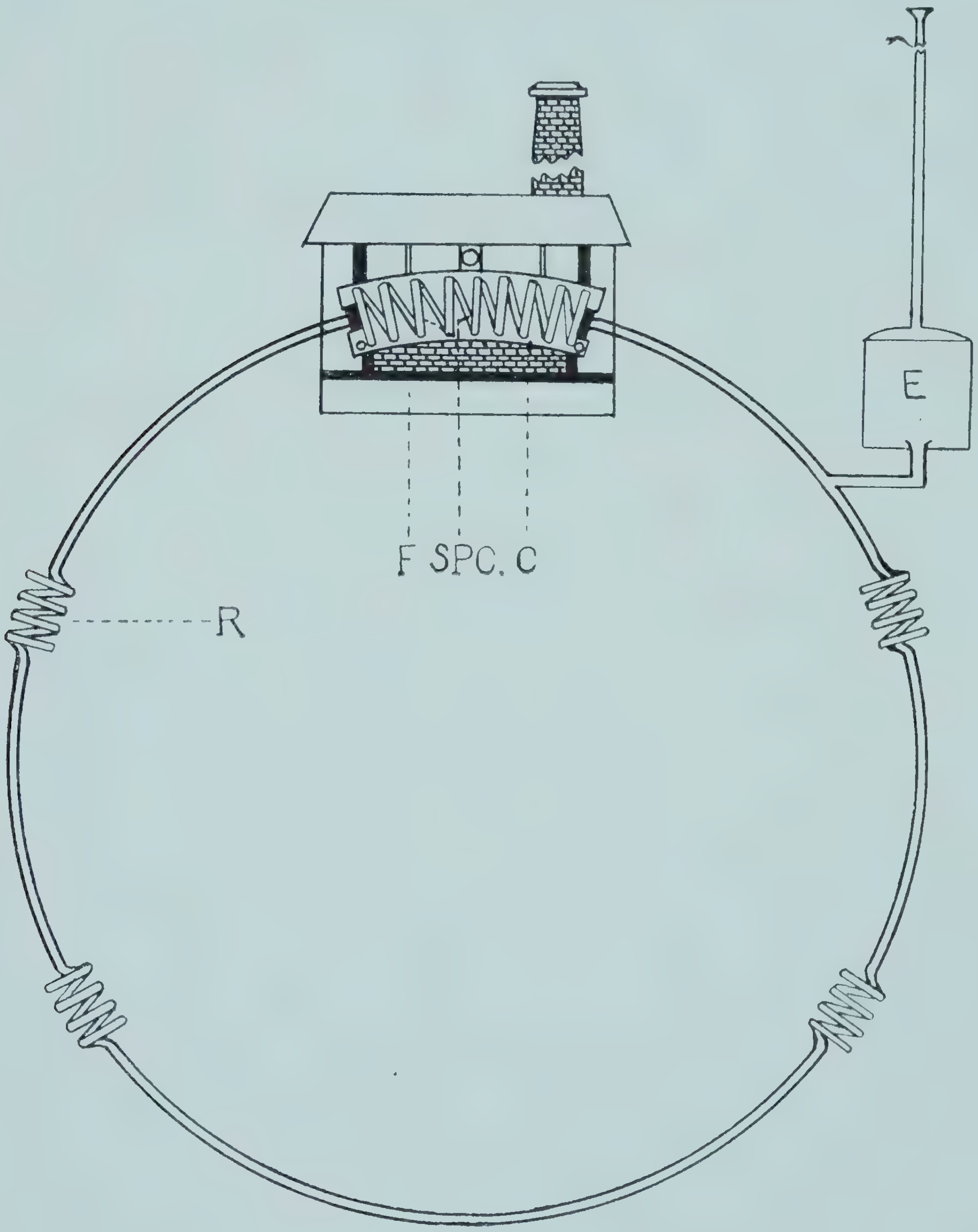

Fig. 63.—High Pressure Hot Water System.

C, Calorifier. F, Furnace. E, Expansion Tank. R, Radiator.
SPC, Spiral Coil in Furnace.

Steam, where available, as in factories, furnishes good central heating. It may be used with or without radiators. It may depend for its circulation either on gravity or mechanical methods. High-pressure steam systems are suited for the transmission of heat to a distance. On the vacuum plan, condensed steam is led back to the boiler by a separate set of pipes and the live steam circulates at low pressure.

Hot Air. Using mechanical methods air can be heated if desired to a temperature which enables it to be used for the purpose of warming buildings. The *Hypocaust* at Liverpool Cathedral is a system of 12 by 9 inch under-floor ducts in closed circuit along which air heated to 150° F. is propelled by a centrifugal fan. It maintains air temperature in the Cathedral at about 56° F. Without mechanical aid any system of warming the rooms in a house by distributing hot air in the ordinary way by open circuit is more or less at the mercy of the wind and in consequence unreliable.

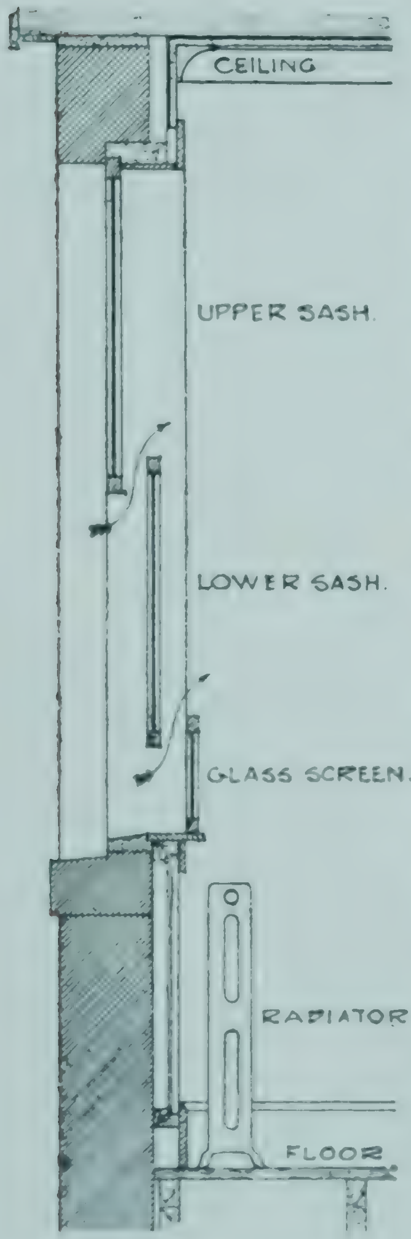

Fig. 61.—Hot Water Radiator at Window.

For a large house or a block of flats or offices in a town a good choice would be central heating by low-pressure hot water, with ordinary radiators or on the expensive panel system if funds permit, together with accessory local warming by electric, gas or smokeless fires. A medium-sized house may be warmed by means of gas or smokeless fires together with electric radiators for short-period heating, and a small house by gas or a smokeless fire.

In a Memorandum recently submitted to the Domestic Equipment Sub-Committee of the Central Housing Advisory Committee, the Society of Medical Officers of Health recommend solid fuel burning stoves for use in kitchens and living-rooms, with adjuvant heating by electric fires when required. They are much in favour of the Yorkdale No. 3 back-to-back range unit, which provides heating in the living-room and cooking facilities in the kitchenette, and also warms upper bedrooms by means of a convection flue. Electric fires are advocated for the heating of bedrooms, and the Memorandum has good to say of District Heating, on the plan now contemplated by Westminster City Council.

In towns all fuel burned should be smokeless and all cooking should be done with gas or electricity. In the country the burning of bituminous coal is unobjectionable, and in large houses that are centrally heated the boiler may be coal- or anthracite-fired.

Whatever the method of heating adopted it should be remembered that buildings, once they have been warmed, do not persist in that condition. They continually transmit heat out through their walls and roofs. As wind greatly accelerates heat loss, all houses should, as far as possible, be built wind-resistant. Houses with fissured walls and ill-fitting windows are at the mercy of the wind. Even when the wind is still they tend to be cold, since any warm air in them, as it rises, finds ready egress through their flaws. At the present time it is common experience that well-built houses after exposure to the blast of high explosive, though not rendered structurally unsafe, are left more difficult to warm than they were before.

Houses with thin external walls, even when proof to the entrance of winds, lose heat rapidly by radiation. Thick substantial masonry walls are conservative of heat, as also are double walls and walls lined internally with wood-panelling. Of all permanent habitations the small house, standing alone, loses most by radiation. A large house standing alone is self-protected, since it will have its warm and its cold side. Joined houses, other things being equal, are warmer than solitary houses, and flats in multi-storey buildings are warmer still.

In cold weather all houses part with much heat through their window glass. There is therefore no virtue, so far as this country is concerned, in causing the windows of inhabited rooms in ordinary houses to exceed the approved one-tenth of the floor area. In very exposed situations double windows are useful, enclosing between them a parcel of air from 4 to 6 inches across which acts as a buffer against the intrusive elements.

SMOKE

The unregulated combustion of bituminous coal is the principal cause of the smoke nuisance which has been estimated to cost Great Britain more than £80,000,000 per annum. Coal smoke consists of particles of unburned carbon, of gases such as the monoxide and dioxide of carbon, sulphuretted hydrogen and sulphur dioxide, and of sulphur trioxide either crystalline or combined with water to form sulphuric acid. Grit and coal tar are present also, the former mainly in factory smoke, the latter in the smoke of domestic fires. The sunlight over towns is substantially diminished by smoke, and ultra-violet radiation often cut off entirely.

The sulphuric acid in smoke transforms the amorphous $CaCO_3$ of sandstone into the crystalline $CaSO_4$ which splinters the face of the stone. Deposited soot chokes plants by blocking the stomata of their leaves, so that they fall early. In houses soot swells the outlay on soap. Domestic and industrial chimneys each contribute, on an average, 50 per cent. of the general smoke nuisance, but wide local variations occur.

Smoke by excluding sunlight in winter lowers the temperature of the air to condensation point and so generates fogs, which impede transport and lead to expenditure on artificial illumination. Smoke fogs, when combined with cold, augment the respiratory mortality owing to the irritating character of their components. In Glasgow in 1909 a dense five-day November fog raised the weekly deaths from bronchial diseases from 75 to 138 in the actual fog week, and 233 in the week after. The fog on the Meuse in December, 1930, which lasted along with severe frost for three days, caused sixty-three deaths from suffocative bronchitis. There were too few domestic fires in the area to produce a general atmospheric uplift, and the fumes and combustion gases rising from the factories were quickly cooled in the frosty air and sank back upon the people below. SO_2, SO_3 and possibly HF appear to have shared the blame.

Having regard to the needs of aviation the detrimental effects of smoke may be far reaching. The smoke cloud may impair or ruin that clear visibility which speeds the pilot on his flight. It screens off light, or diffuses the rays proceeding from visible objects. It may itself shine in the sun, dazzling the eyes. Such interferences may be traced for considerable distances down the wind from the town or area where the smoke originated. The haze of London may be carried to France. The smoke trail of industrial Germany used to reach the south of England. That from English factories has lowered visibility as far away as Valentia in County Kerry.

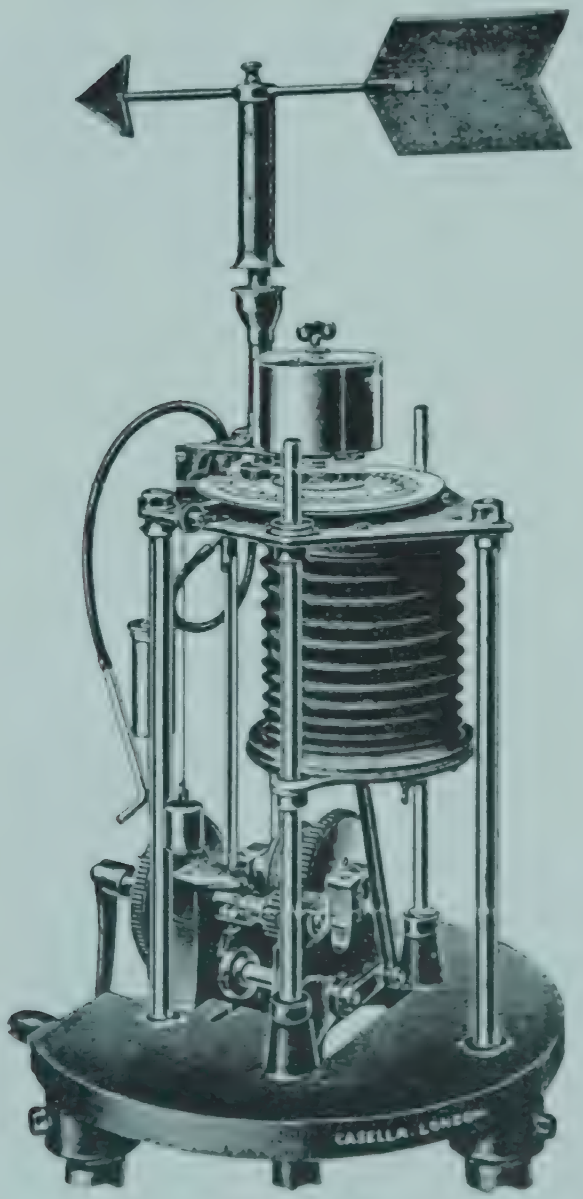

Fig. 65.—Owens Weight-operated Automatic Air Filter.

Atmospheric pollution is measured officially by means of a standard gauge which consists of a metal basin, 70 cm. in diameter, protected by a wire cage and mounted over a glass reservoir. Soot deposited in the basin is washed by rain into the receiver, the contents of which are analysed monthly. The analyses take note of soluble and insoluble matter, tar, ammonia and other compounds. Results are generally expressed as tons of solids per square mile. The extent to which the smoke pall interferes with sunshine may be determined by observing the time required to bleach a standard solution of acetone methylene blue exposed to daylight in a quartz tube at roof height. In the Owens Weight-operated Air Filter (Fig. 65), one litre of air is drawn by means of a small bellows through the margin of a filter paper disc, marked off in quarter hours, upon which suspended impurities are deposited as dark spots. At intervals of 15 minutes the paper automatically takes up a new position. At the end of the day the disc is removed and the spots are compared with a calibrated scale of shades, reading from 1 to 20, no. 1 of which corresponds to a pollution-density of 0·32 mg. per cubic metre of air. The Owens Smoke Emission Meter (Fig. 66), employs thumb-operated revolving vanes to produce varying shades of grey when the instrument is held up to the eye. By adjusting the relative positions of the vanes, a shade matching that of the chimney smoke is readily obtained and the degree of its intensity is read off directly from a scale based on the various vane adjustments.

The Ringelmann Smoke Charts, engraved on glass, provide a simple method for field work. Six charts are supplied, numbered zero to 5

The first is white and the sixth black. The intermediate charts are shaded respectively light grey, dark grey and very dark grey. By holding the charts in such a way that they can be viewed simultaneously with the chimney, a rapid estimate of smoke density may be made.

The remedies for domestic smoke are smokeless low-temperature carbonisation fuel, the anthracite stove, gas heating, electrical heating and central heating in its various forms, using a coke-fired boiler. Domestic smoke is free of the law.

For industrial smoke much can be done by skilled hand stoking. Classes are held, for steam-boiler firemen and others, under the auspices of local branches of the National Smoke Abatement Society. Higher chimneys and the forced steam draught both aid combustion. Smoke indicators, inserted low in the stack and working by means of a selenium bridge or light-sensitive cell, can be wired up to a lamp in the furnace room, which will show a warning light whenever the smoke ascending the stack becomes too dense. Mechanical stokers with underfeed introduce the raw fuel into the heart of the fire, where it is completely burned. Coal-dust firing has been advocated. Substitute fuels may be used, such as coke, gas or petrol, or substitute power in the form of electricity. The waste smoke from industrial processes for which a smoky heat is essential should be led to a waste-heat boiler or a special waste-heat furnace.

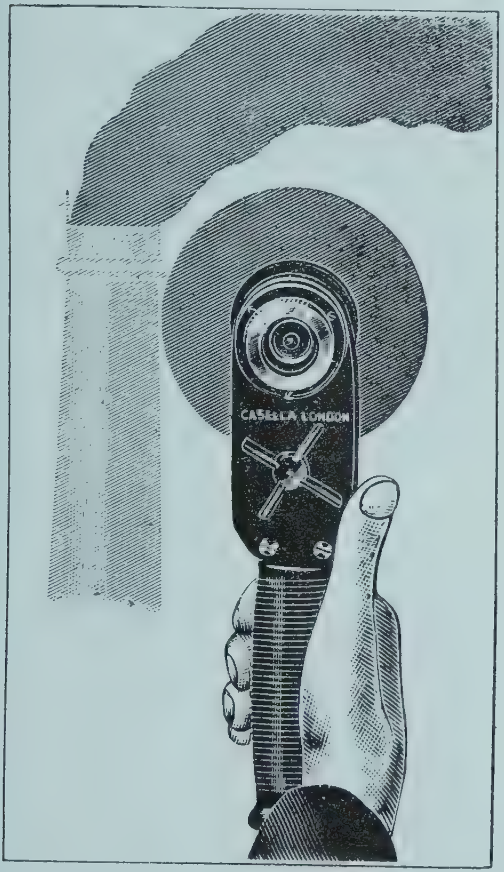

Fig. 66.—Owens Smoke Emission Meter.

Since power stations and other large-scale works of the kind are among the principal sources of the deleterious SO_2 and SO_3 liberated by furnaces, stations such as Battersea and Fulham have been required to take the best practicable means for the removal of sulphur fumes from their flue gases. The fine response of Fulham to this requirement is pictured in Figure 67. Thanks to the flue gas washing plant, not sulphur alone but also all grit, soot and dust are extracted from the smoke, leaving steam only, which is launched upon the air as a transient white plume of innocuous water vapour.

During the Second World War smoke legislation was largely in abeyance on account of the need for increased factory production. This led to considerable increases in the amounts of both smoke and grit in the atmosphere. The restricted allowances of coal for household fires under the Fuel and Lighting Directions reduced the volume of domestic smoke. On balance the increase of total smoke production was measurable. In Glasgow in 1942 the precipitation of solids from the air was 259 tons per square mile, exceeding by nearly 6 per cent. the average of previous years.

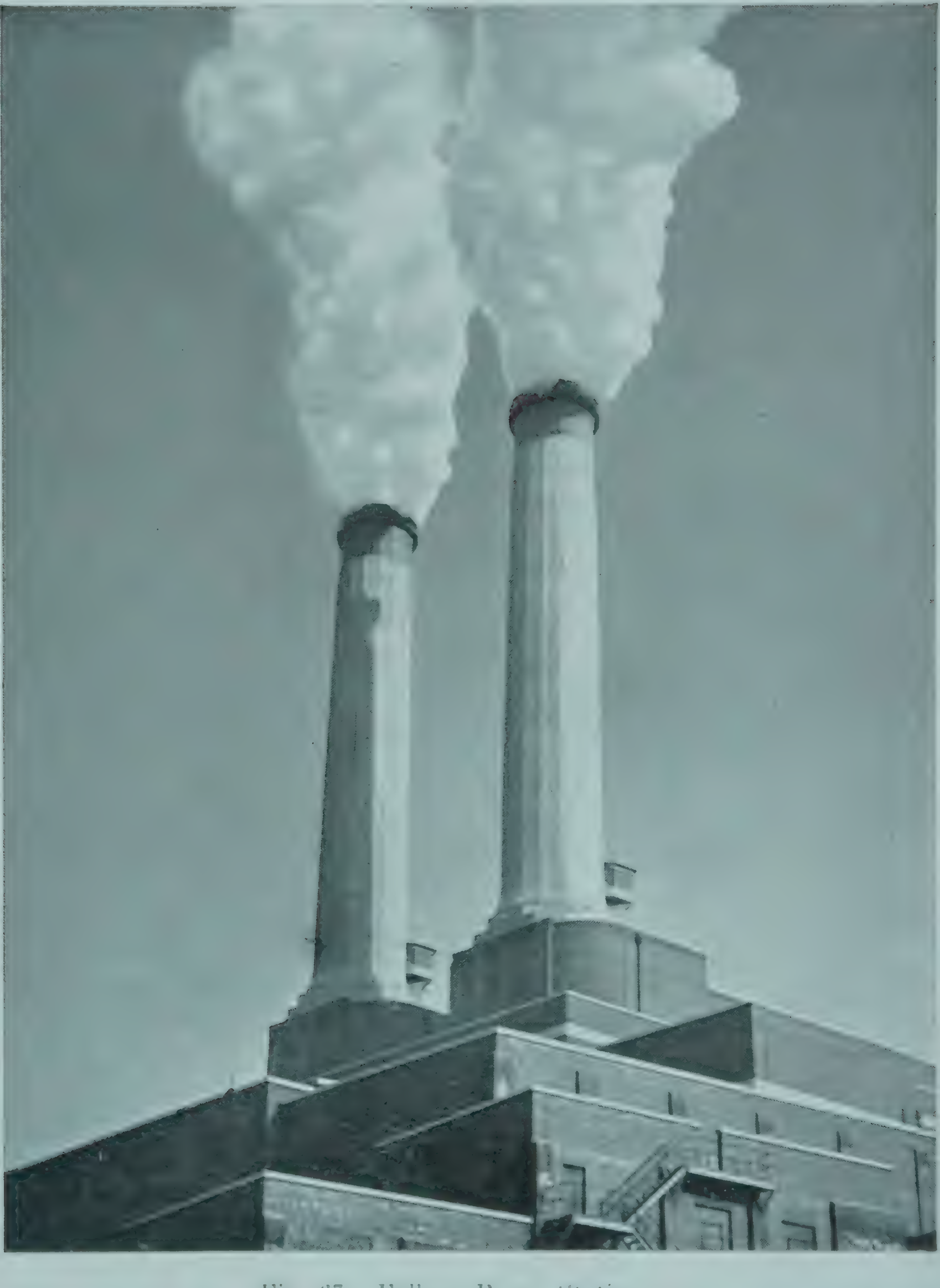

Fig. 67.—Fulham Power Station.

In the planning and rebuilding of post-war Britain, one of the objects of which is the promotion of amenity, every effort should be made to secure that, before many years have passed, a smokeless atmosphere shall be as much the rule in towns and cities as it is now in the open country. For the prevention of domestic smoke it will be necessary to suppress in towns the unregulated burning of bituminous coal in open fires, which by reason of their simplicity, their genial warmth and their 'hearth and home' associations will probably continue to be held in affection by many. If, however, local authorities can see their way to devote the same attention to the maintenance of adequate supplies of good smokeless fuel as they now give to the production of gas and electricity, the open fire, with suitable modifications, should still hold a place, especially in single, semi-detached and joined terrace houses. Flats in tenement buildings should be all-electric, or have electricity *plus* gas, or derive their heat from central hot-water boilers, coke-fired and therefore smokeless. By the use of such measures the desirable residences to be new-erected in towns once smoke-oppressed should, instead of turning black, retain for years their pristine attractiveness in sunshine and clear air.

The smoke problem is plain enough. So is its solution. It remains to determine the most expeditious way of applying the remedy. Three lines of approach have been suggested: (1) to prohibit from an appointed day the emission of smoke throughout the whole country: (2) to have smoke emission declared an offence and thereafter to take appropriate action gradually: and (3) to proceed straight away, where most required, to establish smokeless zones or areas, to which adjacent areas might afterwards be joined. No. 3 seems the best of these lines of approach.

Public Health Act, 1936. This Act gives English local authorities power to deal with smoke nuisances as nuisances under the Act, but not if the chimney emitting smoke is the chimney of a private house. 'Smoke' under the Act includes soot, ash, grit and gritty particles. 'Chimney' includes structures and openings of any kind from or through which smoke may be emitted. The Act empowers local authorities to make byelaws with regard to smoke nuisance. Smelting and other metal works are exempt from the smoke provisions of the Act.

Public Health (Scotland) Act, 1897.

16 (9). Any fireplace or furnace in a burgh or special scavenging district, which does not so far as practicable consume its own smoke, whether for working engines by steam or for any manufacturing or trade process whatsoever, shall be deemed to be a nuisance under the Act.

16 (10). Any chimney, not being the chimney of a private dwelling house, sending forth smoke in such quantity as to be a nuisance or injurious or dangerous to health, shall be deemed to be a nuisance under the Act.

Burgh Police (Scotland) Act, 1892.

384. Every person responsible for using any furnace or fire, except a household fire, so that smoke issues therefrom, unless he proves that he uses the best practical means, and has taken care to prevent, as far as possible, the escape of smoke, shall be liable to a penalty. This enact-

ment applies to steamers plying on a river or estuary, but is not intended to obstruct the working of mines or metal trades.

The nuisance procedure of the statutes quoted is applied to producers of excess industrial smoke by local authorities. Observations of peccant chimneys are made by sanitary inspectors or special smoke inspectors. Times are noted and photographs taken. Excess industrial smoke in Glasgow means the escape of dense smoke for over two minutes in an hour. In England the Minister of Health has approved for some areas byelaws constituting an aggregate of two minutes black smoke in half an hour a nuisance. As already indicated, domestic smoke stands above the law.

In former days the hydrochloric acid generated in the alkali manufacture was allowed to pass freely into the atmosphere. Now in terms of the Alkali, etc., Works Regulation Act not more than $\frac{1}{5}$ of a grain of HCl, and not more than the equivalent of 4 grains of SO_3 are permitted in one cubic foot of the chimney gases.

XII.

LIGHTING

RADIATION is wave motion in the hypothetical ether. It is defined by wave length, frequency and amplitude. All forms are transmitted with the same velocity. Wave length is inversely proportional to frequency. The shortest radiations are the Millikan rays, with a wave length of 0·0004 Å, the Ångström or Å being one ten-millionth of a millimetre. The γ rays, thrown off by radium, have a length up to 0·1 Å and the X-rays from 0·1 Å upwards. In the ultra-violet region the wave length is from about 1000 to 3900 Å. For the visible spectrum the one limit is at 3900 Å, the shortest violet: the other at 7700 Å, the longest red. In the infra-red the wave length extends from visible red to about 0·01 cm. The Hertzian or electro-magnetic waves range from the neighbourhood of 0·2 cm. up to thousands of metres. The rays of the visible spectrum penetrate glass: the infra-red rays are arrested by it. Hence the warmth generated in glass-roofed verandahs, in which the light rays after entrance are transformed into heat which cannot readily make its escape. Ordinary window glass, which transmits no rays shorter than 3300 Å, denies a passage to most of the ultra-violet radiation. Very thin glass however transmits the short rays. Quartz is transparent to the greater part of the ultra-violet radiation and it is claimed on behalf of certain special glasses now on the market, referred to below, that they are similarly pervious.

LIGHT MEASUREMENT

Candle Power. The intensity of light, called its Candle Power, is estimated by comparison with a standard source, originally the standard sperm candle burning 120 grains per hour, now a standard electric light checked at the National Physical Laboratory and elsewhere. The measurement is made by means of a Photometer, such as the Holophane Lumeter, Luxometer or other portable type of instrument employed for photometric surveys, or the larger Bar Photometer used in laboratories. The lights from the lamp under test on the one side and from the standard source on the other are made to illuminate a screen between them, and the distance between the lamp and the screen is varied till the brightness is the same on both sides of the screen. By the law of inverse squares the strengths of the lights are inversely proportional to their distances from the screen. Therefore if $a =$ distance of test lamp from screen, $b =$ distance of standard from screen, and C.P.= candle power,

$$\frac{\text{C.P. (Test Lamp)}}{a^2} = \frac{\text{C.P. (Standard)}}{b^2} \text{ and C.P. (Test Lamp)} = \text{C.P. (Standard)} \times \frac{a^2}{b^2}$$

Horizontal candle power is candle power along a horizontal line. Mean horizontal candle power is mean candle power in the horizontal plane. Mean spherical candle power is mean candle power in three dimensions.

Lumen. The light flux or amount of light emitted by a lamp is expressed in lumens. One Lumen is defined as the amount of light falling on a surface of one square foot every point of which is one foot distant from a point source of one candle. One mean spherical candle power is equal to 12·57 lumens.

Foot-Candle. Illumination is the amount of light incident on a surface from a source or sources. The unit of illumination is the Foot-Candle, being the illumination of an area every point of which is one foot from a uniform point source of one candle power. It is a measure of the density of light flux. One foot-candle corresponds to one lumen per square foot. The number of lumens divided by the area in feet gives the illumination in foot-candles.

Reflection Ratio. The reflection ratio, or coefficient of reflection, of a lit surface is the fraction of the incident light returned by the surface, expressed as a percentage.

LIGHTING STANDARDS

The Factories (Standards of Lighting) Regulations, 1941, require the following intensities to be provided.

Over the working area and gangways round it at 3 feet above floor level, 6 horizontal foot-candles. In other parts such as stairways and passages, 0·5 foot-candle.

The Departmental Committee on Lighting in Factories and Workshops recommended 3 foot-candles for fine processes and 5 foot-candles for very fine processes. The Lighting Service Bureau's recommendation for factory processes is 5 to 50 foot-candles, depending on the fineness of the work.

The Board of Education suggests the following minima for various rooms.

	Foot-Candles.
Class rooms, libraries, craft rooms, art rooms, workshops and staff rooms	10
Needlework rooms	12
Gymnasia, assembly halls and dining rooms .	8
Corridors, staircases and cloak rooms . .	6

Among the standards recommended by the Lighting Service Bureau for public buildings and institutions the following may be cited.

	Foot-Candles.
Hospital wards	3-5
Hospital operating theatres	12
Hotel kitchens	8-15
Hotel lounges	6
Library reading rooms	10
Typists' rooms in offices	8-15

SUNLIGHT

The natural illumination in any locality is primarily conditioned by its share of sunlight. Sunshine is affected by season, latitude, the humidity of the air and the amount of smoke present. The daily duration of bright sunshine in Britain, on a thirty-year average, was for Glasgow 2·98 hours, for Birmingham 3·10 hours, for Westminster 3·23 hours and for Oxford 4·13 hours. The sun has a lighting power up to 10,000 foot-candles, bright clouds may give 5000 foot-candles and a slightly clouded sky 3000 foot candles. A dull day would be represented by 500 foot-candles. Most of the ultra-violet radiation delivered by the sun is arrested by ozone in the high air. What remains is further curtailed by mist and smoke in the lower atmosphere. The radiation from bright clouds may be one-half that of the sun and the radiation from a clear sky one-tenth. Mountain sunlight has more ultra-violet rays than sunlight on plains. On the Alps more ultra-violet rays come from clear blue sky than from the high sun.

Ordinary window-glass, which passes the spectral rays freely, checks practically all the ultra-violet rays, but, if very thin, is pervious to some. Certain glasses now on the market, understood to be iron-free, are specially prepared with a view to ultra-violet transmission.

NATURAL LIGHTING

Whatever the amount of light may be in the open the natural lighting in buildings is necessarily below it and usually far below it. The *daylight factor* is the percentage ratio of internal to external illumination determined by means of a photometer. If I be the internal illumination in foot-candles, E the external illumination in foot-candles and D.F. the daylight factor, then

$$\frac{\mathrm{I}}{\mathrm{E}} \times 100 = \mathrm{D.F.}$$

Taking external illumination as that of a dull day, namely 500 foot-candles, a daylight factor of 0·2 would give 1 foot-candle of internal illumination, which is too little. In industry the operatives complain of 0·2. It is the ‘grumble’ limit. A factor of 0·5 would give 2·5 foot-candles, which is adequate. A factor of 1 would give 5 foot-candles, which is good.

For house illumination both direct sunshine and diffused daylight are needed. Diffused daylight is light without deep shadows. Its strength should be sufficient to enable the housewife to carry on her domestic work without difficulty and to see without difficulty whether surfaces are clean. This means that the windows should extend up to near the ceiling in order that the skyshine may reach right across the floor to the back wall of the room. If the window is blanketed by a high building so that the visible sky is reduced to a ribbon, the room is insufficiently lighted. Clean windows are essential to brightness and light-coloured walls help. The window space, as already noted, should equal $\frac{1}{10}$ of the floor space. Adequate window light should be provided on all staircases.

The natural lighting in schools should be lateral, preferably from left-hand windows, failing which from windows on the right. If general warming is adequate and there are hot-water radiators at the windows, the window space may rise to $\frac{1}{5}$ of the floor space. There is no point in carrying windows down to the floor, as glare will be caused by any light which comes in below desk level. A daylight factor of 0·5 is regarded as adequate for a schoolroom.

For work in factories natural lighting is best. Given equal foot-candle intensity, fatigue usually sets in more quickly with artificial light than with natural light. Every hour of artificial illumination, it has been said, means loss of production.

ARTIFICIAL LIGHTING

Electricity is now in general demand for artificial illumination. It is often cheaper than gas. In the incandescent lamp there is a coiled filament of tungsten wire which is raised to a white heat by the passage of the current. The 'coiled-coil' type of filament has a higher luminosity. The filament is in a glass bulb filled with an inert gas such as nitrogen or argon. The opal type of bulb yields a diffuse radiance, while effectively concealing the tungsten element (Fig. 68). Five per cent. of the current is available for lighting, the remainder being expended as heat. The incandescent lamp thus warms the air, without consuming oxygen or liberating combustion gases.

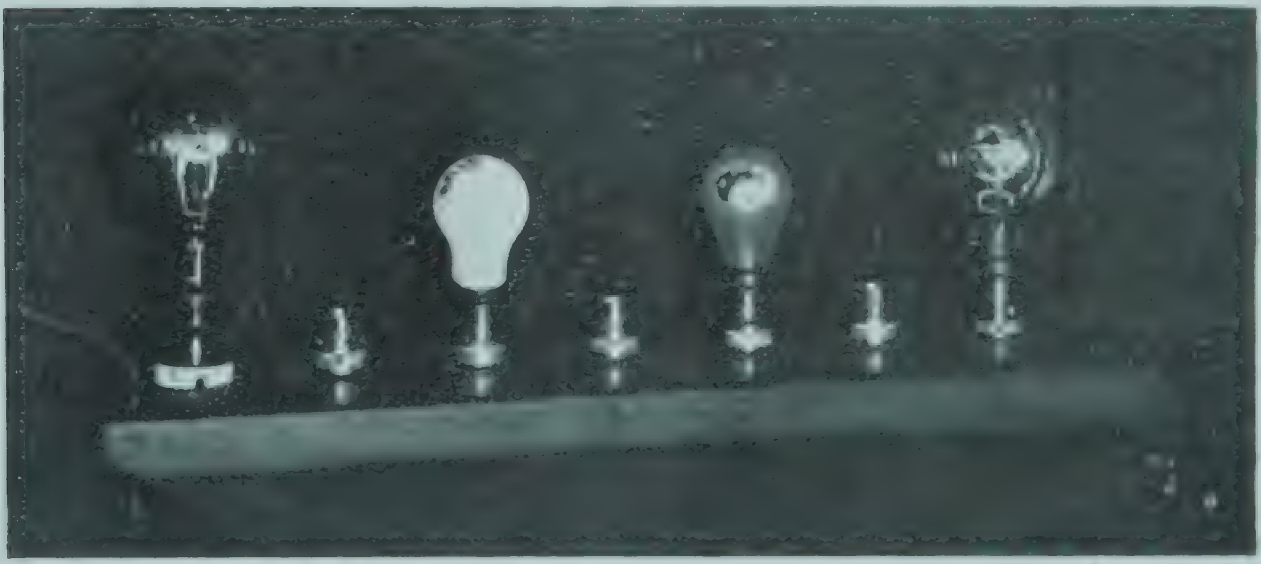

Fig. 68.—Electric Lamps.

The types of bulb, reading from left to right, are: Gas Filled: Opal: Pearl and 'Daylight.' The opal bulb yields a diffuse radiance and conceals the tungsten element.

For high-power lighting the vapour lamps, known also as 'electric discharge hot cathode' lamps, now hold the field. The neon-filled sodium discharge lamp gives monochromatic yellow light, but it defines objects clearly and has been found good for highways. The argon-filled mercury discharge lamp issues no red rays, hence its death-like effect. This last disadvantage has been overcome by using a pressure of five atmospheres in the lamp. The mercury lamp, which is more powerful than the sodium lamp, is good for highways and factories. A recent development is the fluorescent tubular discharge lamp, coated internally with a powder which fluoresces in the ultra-violet rays generated from mercury vapour within the lamp. It yields a cool light of low surface brightness at no greater running cost than that of the bulb lamp. The entire tube glows with a white light, glareless and shadow-free. The bright red rays of the 'cold cathode' neon lamp are employed for decorative purposes. The arc lamp, though superseded as a general illuminant, still renders valued service in the field of light therapy.

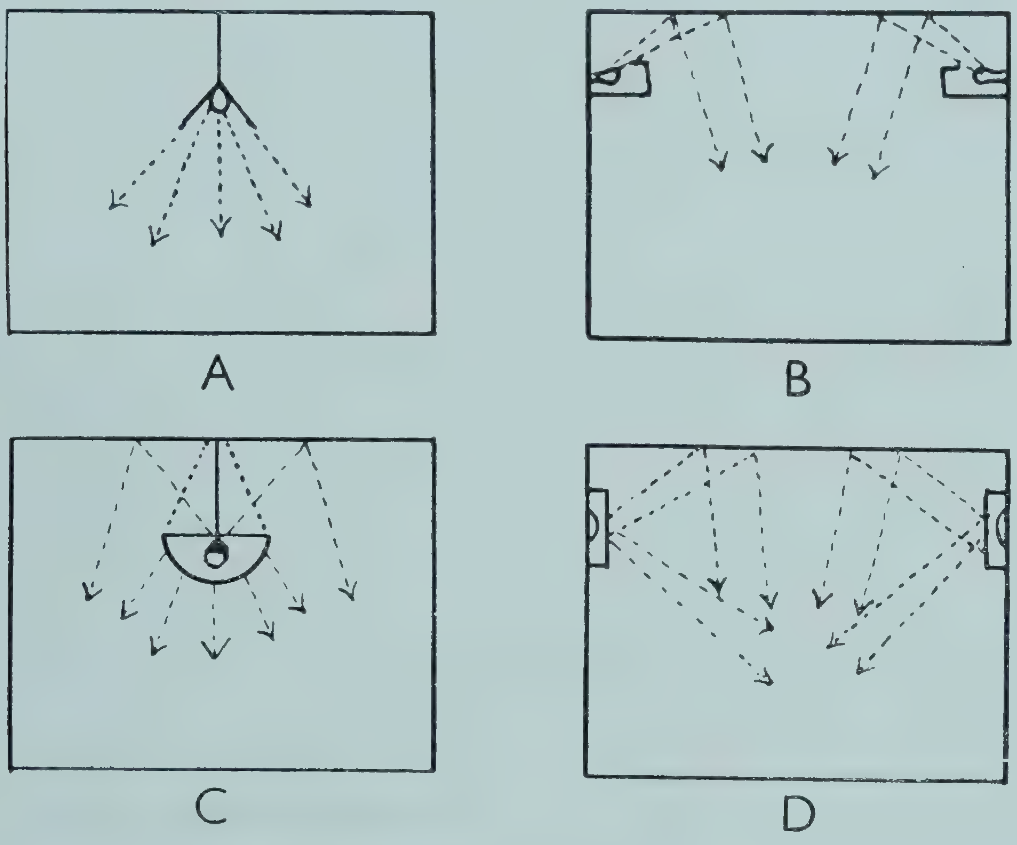

Fig. 69.—Lighting Methods.

A. Direct.
B. Indirect.
C. Semi-indirect.
D. Enclosed Diffusing.

In indoor lighting by electricity the following methods of light control may be used (Fig. 69).

(a) *Direct Lighting.* Light is received from the source direct or partly by way of a reflector. This method is efficient but causes glare and hard shadows.

(b) *Indirect Lighting.* Lamps are recessed in a cornice, or otherwise totally concealed. All light is thrown on the ceiling, which returns a borrowed radiance of a restful and shadowless quality. It should however be kept in mind that indirect light giving 12 foot candles or under, if perfectly uniform, is apt to produce in the mind feelings of gloom and depression. Such feelings may be dispelled by introducing a few visible points of light, which may be coloured if desired, to give sparkle.

(c) *Semi-indirect Lighting.* The lamp is in a translucent shell which is open above. Part of the light received passes through the shell, and part is reflected from the ceiling. The general effect is mild and agreeable.

(d) *Enclosed Diffusing Units.* The light source is enclosed in diffusing glassware. Some of the light is received direct from the diffusing glass: some after reflection from the ceiling. The illumination is without glare or hard shadows.

Incandescent lamps supply a light which, though white in appearance, contains more yellow rays than daylight. In the daylight lamp, necessary for matching colours, the incandescent rays are filtered through blue glass which cuts off the excess of yellow. The bulb of the flame-sprayed lamp contains a trace of red and so transmits a genial light. Opal glass lamps and white-sprayed lamps give a diffused light with softened shadows. The arc lamp is rich in ultra-violet rays: hence its remedial uses. The ultra-violet radiations of the mercury vapour lamp are stronger than those received from the sun at ground level.

The facilities afforded by electricity have had the effect of raising the standards adopted in practice for the artificial lighting of buildings.

Coal Gas for lighting purposes is best burned in a Welsbach burner, inverted type. A Bunsen burner with non-luminous flame plays on a mantle of asbestos gauze treated with zirconium sulphate, heating it to incandescence. A burner of 50 candle-power burns 3½ cubic feet of gas per hour and produces 1·8 cubic feet of carbon dioxide. Instead of coal gas, water gas may be burned in the Welsbach burner, or water gas mingled with coal gas or calor gas.

Acetylene, C_2H_2, evolved from calcium carbide, CaC_2, by the action of water, burns with a brilliant white flame. Escaping acetylene forms an explosive mixture with air at 1 part in 7.

Paraffin Oil is burned by means of a wick enclosed in a glass chimney. The flash point of the oil is the temperature at which its volatile hydrocarbons ignite. The Petroleum Act set a flash point not below 73° F. The paraffin lamp should be of strong construction and should stand on a firm base. It should be equipped with an extinguisher and also with a contrivance to extinguish the flame if the lamp is overturned. The oil reservoir should be of metal. The paraffin lamp, for equal lighting power, produces more CO_2 than a Welsbach gas burner. Petroleum or paraffin pressure vapour lamps with burners and incandescent mantles give a brilliant white light and are highly efficient.

GLARE

Glare is an unwished-for brightness intruding into the field of vision. It dazzles at the working bench and may reduce visibility by 50 per cent. or more. A disturbing strong light may be shaded, or a shade worn over the eyes. The Factories (Standards of Lighting) Regulations, 1941, require bright lights in work rooms to be shaded with opaque material or otherwise housed so that no operative is exposed to glare. The reflected glare from polished metal or satin cloth is prevented by placing the worker so that the light falls sideways on his work. Good general lighting of the work room is also important. If the bench is brightly lit and the work room in twilight, as the workman looks up from his work and returns to it the iris is kept in continual movement and eyestrain tends to result. The illumination of no part of the work room should be less than 70 per cent. of the maximum on the bench. Lights which undergo abrupt changes of power have also a tiring effect. The glare of acetylene welding is controlled by the use of sage-green glasses. In electro-welding, which produces ultra-violet radiations, the eye may be protected by ruby glasses between two blues. For the bright light of molten iron or steel above 2000° F. the glasses worn should be blue or sage-green. The cataracts which occur among glass blowers and tin-plate workers are mainly due to radiant heat.

XIII.

WATER SUPPLY

Water, besides being one of the essential food components, is requisite also for cooking and cleanliness and for the removal of waste products from houses. In towns it serves municipal purposes and trades consume it in large quantities. A pure, wholesome, copious and conveniently accessible water supply is a potent aid to individual health and communal prosperity.

SOURCES

The source of replenishment of water supplies is the aqueous vapour of the atmosphere, which falls to the ground as rain, hail and snow. Part of the rain returns to the air by evaporation: part runs off as surface water to produce streams, rivers and lakes: and part percolates through the soil to constitute the underground water, which may reappear as visible springs or issue unseen in the bed of rivers and lakes. The snowfall, melting in its lower layers through the upward radiation of heat from the earth, sinks steadily into the ground it covers, and plays an important part in recharging the subterranean stores of water which feed springs and wells.

Utilisable water thus occurs in Nature in the three principal forms of (1) Rain Water, (2) Surface Water and (3) Ground Water.

RAIN WATER

Rain contains atmospheric gases. Near the sea it takes up salt from the air, and in towns soot and other combustion products. Owing to its softness it is good for washing and cooking. As a beverage it is wholesome though not sparkling. Rain water is usually collected from roofs, a rain-water separator being employed to pass the first impure run-off to waste and the remainder to the storage tank. Small rain-water tanks are best made of slate or brick faced with cement. Large tanks may be constructed of reinforced concrete rendered with cement. Tanks should be kept covered to protect them from casual pollution. The average yield of rain from a roof in this country works out at 2½ gallons per head per day.

SURFACE WATER

Surface water includes upland water, streams, lakes and rivers. Lakes often consist mainly of upland water, as do also in their higher reaches rivers which drain uplands.

Upland Water intended to be used for the supply of a town is collected in an impounding reservoir (Fig. 70) which is formed by throwing an earth, concrete or masonry dam across a convenient place in a valley at such a height as to ensure that the impounded water will flow to consumers by gravity. The water is led to the town in aqueducts, which are usually large-bore pipes of cast iron, steel or reinforced concrete. The quantity of water that can be got from the catchment area is worked out from the rainfall. The quantity of water to be drawn off daily is determined by the number of persons in the town.

Good upland waters, being unpolluted, do not usually require bacterial purification, though they may be screened to hold back leaves and moss or filtered to take out colour.

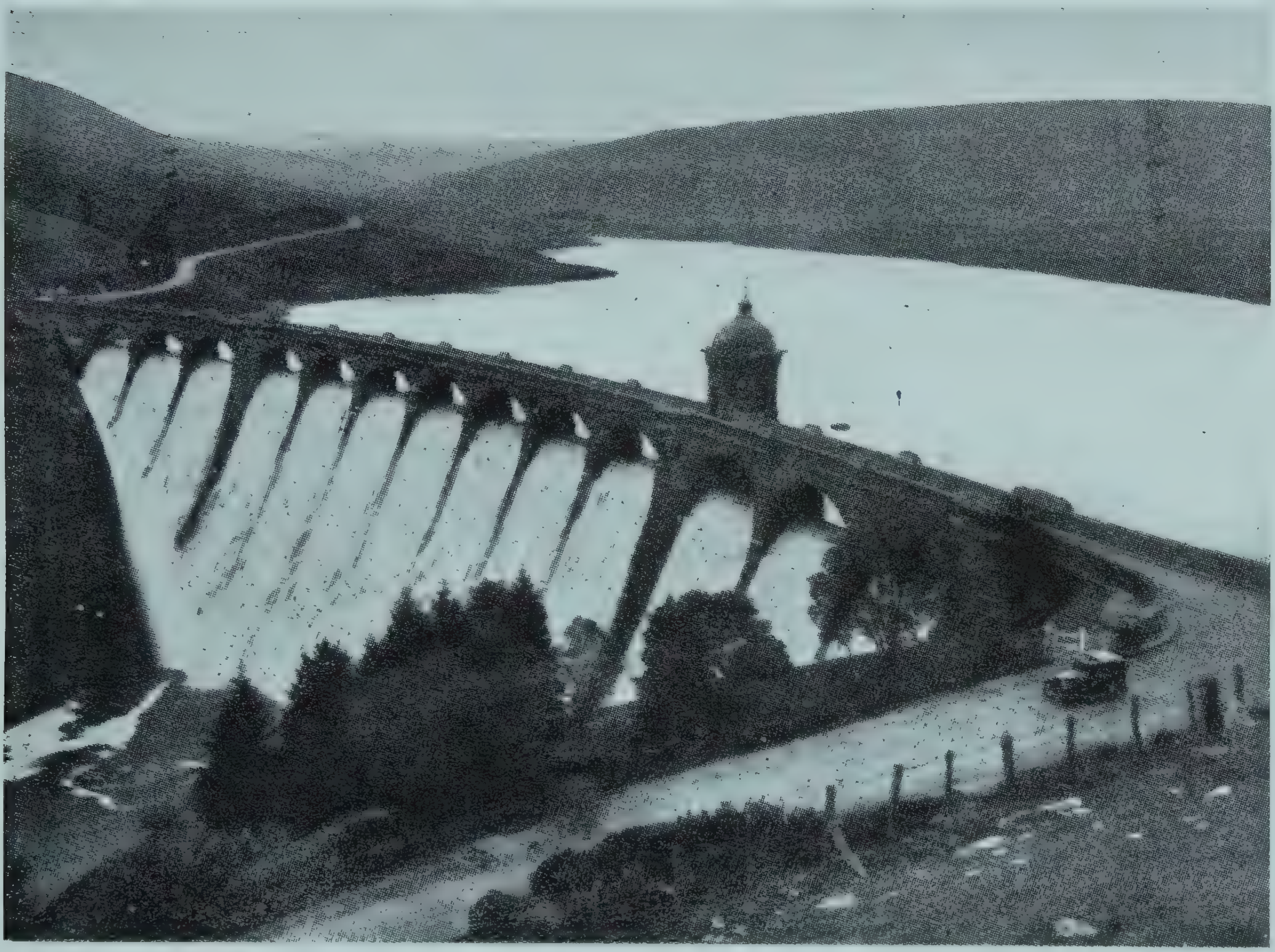

Fig. 70.—Impounding Reservoir: Elan Valley. Birmingham Water Supply.

Streams flowing from unpolluted uplands are good sources for small or temporary supplies. The yield of a stream may be estimated by taking its mean depth in feet and its mean breadth in feet. The product of the two is its cross-sectional area in square feet, which multiplied by four-fifths of the surface velocity in feet per minute will give the yield in cubic feet per minute. From this the supply in gallons per day can readily be ascertained, 1 cubic foot being equal to 6·23 gallons.

Lakes used for water supply in Britain are usually situated in upland country. They supply pure water. They are natural reservoirs fed by the streams which come down from the surrounding mountains. The outlet of the lake is raised to increase storage capacity. The available yield is based upon the dimensions of the catchment area and the annual rainfall.

Rivers. The water of rivers is primarily of surface origin though often augmented by ground water from springs. Most rivers are free of dangerous pollution in their upper reaches. As they descend through inhabited country, draining it in their course, they receive sewage and other effluents which render them unsafe for drinking. Sewage-polluted rivers have a natural tendency to self-purification, which however does not include the destruction of all the pathogenic bacteria introduced by the sewage. If proposed to be used as sources of water supply they require previous purification by special means. Examples are the Tay, the Dee at Chester, and for London the Thames and Lea.

The discharge of sewage into a stream, lake or river is often betrayed by the sewage fungi *Leptomitus* and *Beggiatoa*, which appear as a grey coating on stones and vegetation at the point of entry.

GROUND WATER

The ground water is that portion of the rain or snowfall which penetrates downward into the soil till arrested by an impermeable stratum. It appears in the form of springs and wells.

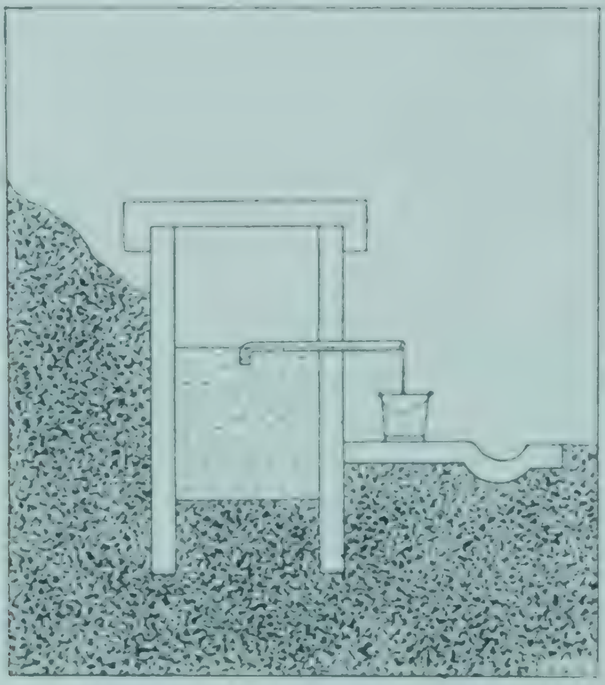

Fig. 71.—Protected Spring.

Springs are natural issues of ground water. Land springs, which occur at the outcrops of superficial impervious strata, are apt to be intermittent. Main springs are derived from extensive water-bearing formations. Good main-spring water is bright, copious and unfailing, though often hard. To prevent the contamination of a small spring by dipping buckets into it, or by casual interference, it should be cased in concrete up to a convenient height above ground level and fitted with discharge pipe and run-off channel for spillage (Fig. 71). Main springs are liable to pollution reaching them through rock fissures. A solution of fluorescein and caustic soda each 1 per cent. poured out at the mouth of a suspected fissure will, if the fissure leads to the spring, show green in the spring water.

Wells are access ways to the underground water, which is raised to the surface by appropriate means.

Shallow Wells tap the ground water over the first impermeable stratum. If this stratum is near the surface the water lying upon it has little protection from surface pollution. If it is deep the surface water, as it sinks, has the impurities strained out of it by the thick layer of soil. The tube well is a variety of the shallow well. It consists of a perforated steel nozzle to which lengths of iron tubing are screwed in succession. The apparatus is driven into the ground length by length, and the water is raised by suction pump.

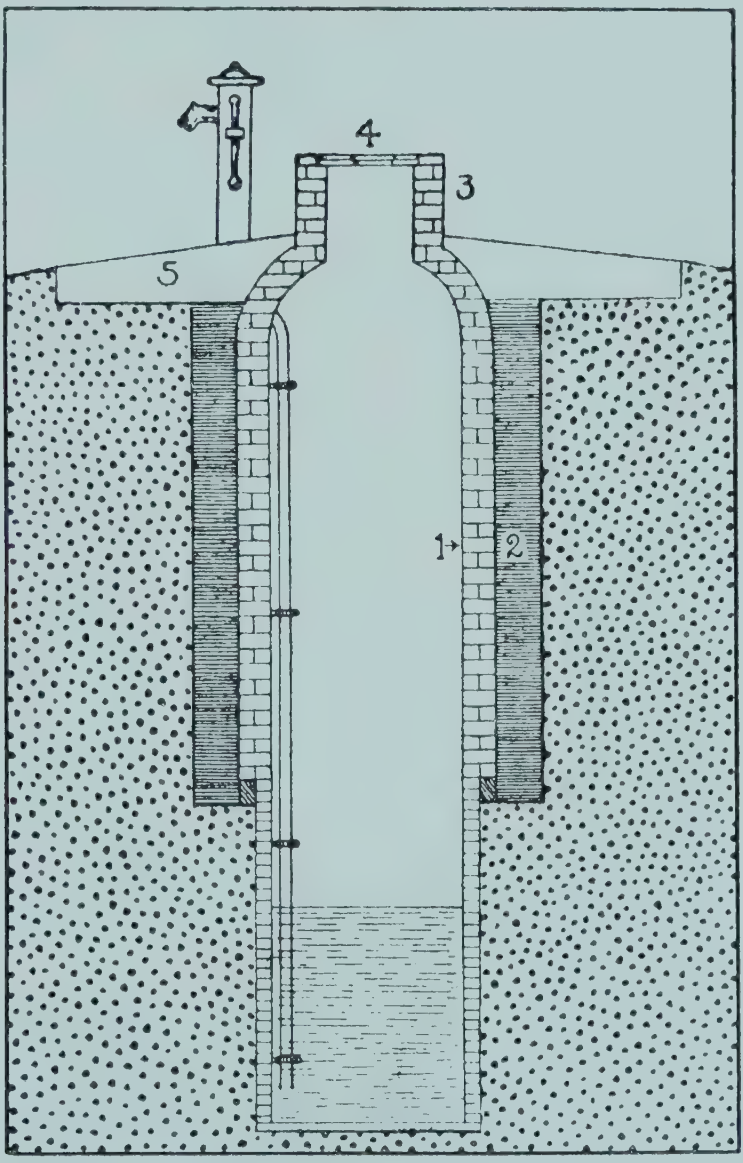

Fig. 72.—Properly Constructed Well.

1 Casing. 2 Clay Puddle Support. 3 Coping.
4 Cover. 5 Shoulder-piece.

Deep Wells tap the water below the first impermeable stratum. This water may have travelled from some distant outcrop where it fell as rain. Good deep well water is translucent, colourless, and germ free.

A properly constructed well (Fig. 72) has a water-tight casing of concrete, brick set in cement, or large diameter close-jointed piping, supported by clay puddle or concrete, and reaching down to the ground-water level, below which the joints are open in order to admit the water to the well. The casing should be carried up to form a coping 18 inches high round the well mouth. Cement concrete is best for the cover of the well, which fits close to the coping, though iron or wood may be used. The well mouth should be surrounded by a cement shoulder-piece about 4 feet wide. A pump should be employed, not a rope and bucket which would cause pollution of the well. The pump should be erected beside the well mouth and not on the cover, and its pipe led through the casing. A channel should be supplied to carry off spillage from the pump. There should be no opening for ventilation. A faulty well (Fig. 73) is one which does not conform to these requirements.

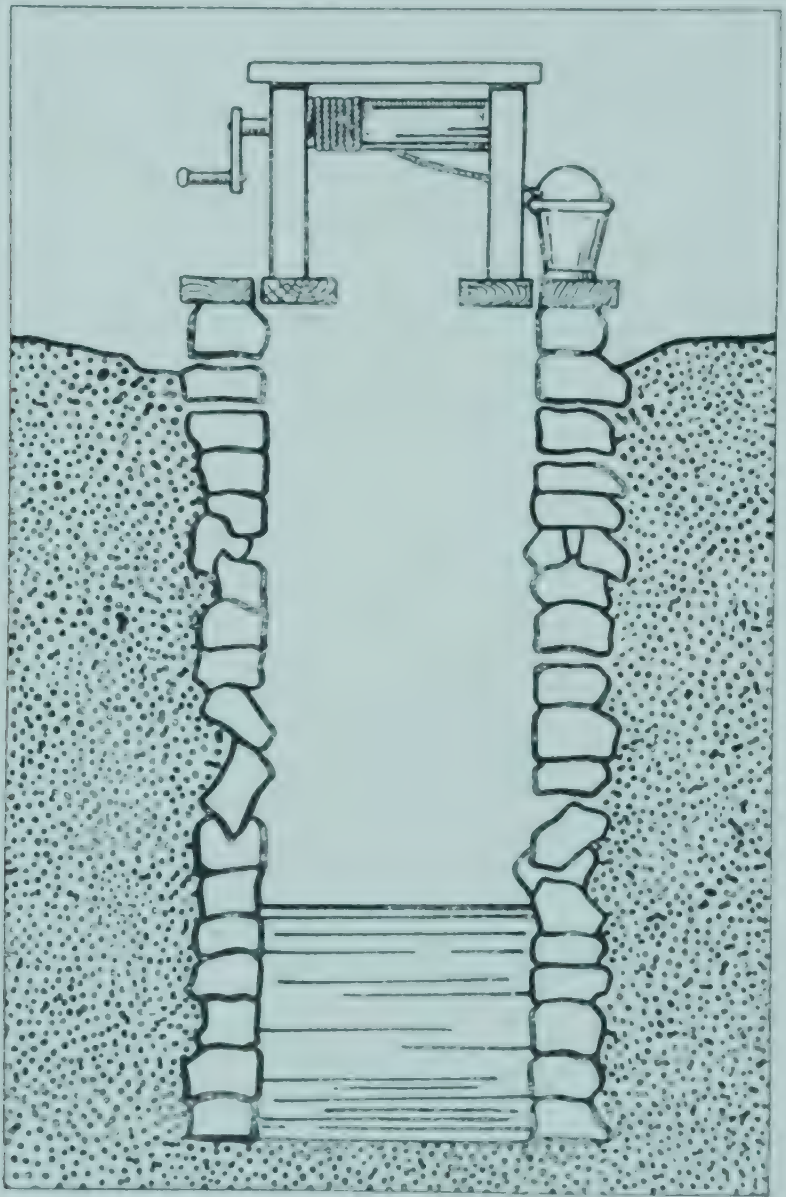

Fig. 73.—Faulty Well.

Flowing Wells, also called artesian, deliver water at the surface, sometimes under pressure enough to throw a high jet. The bore taps an underground supply with its water surface at a higher level than the mouth of the bore. This class of water is employed by brewers on account of its hardness. A number of English towns derive their water supply, in whole or in part, from flowing wells.

QUANTITY

A daily ration of 0.3 gallon of water suffices for the drinking of one person and 0.7 gallon for cooking, making up 1 gallon per head per day for these purposes. If 5 gallons are added for personal ablution, 3 gallons for laundry and 3 gallons for scrubbing and house cleaning, a total is reached of 12 gallons per head per day. For a house in the country with limited water supply this quantity can be made to serve.

In towns with water laid on to houses further allowances require to be made for baths and w.cs., as well as for trade and municipal purposes, including dairies, and waste of water, giving in all 35 gallons per head per day.

This total may be taken as an average for towns in Britain. Both higher and lower figures occur.

A check upon the quantity of water leaving the storage reservoir at any moment of time is furnished by the Venturi meter (Fig. 74) which is placed in the main pipe line. This device depends on the fact that water passing through a converging pipe gains speed and loses pressure in amounts which bear a standard relationship to the diameter of the pipe. The flow is registered automatically upon a dial which is connected by pressure pipes to the narrow throat of the meter. The Venturi meter may also be employed to regulate the dosage in chlorination of water.

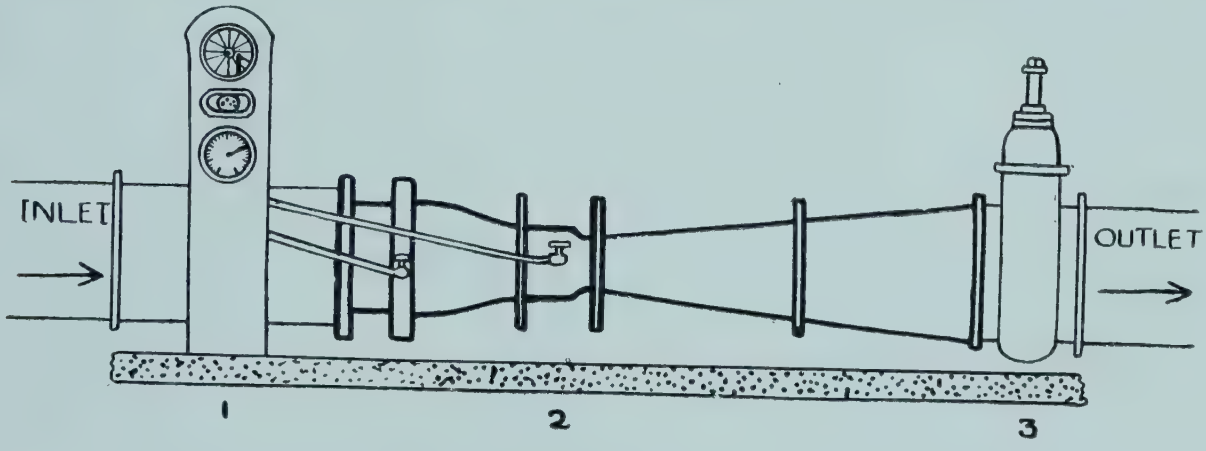

Fig. 74.—Venturi Meter.

1 Register. 2 Throat of Meter. 3 Valve.

DISTRIBUTION

Water is conveyed from the terminal of the aqueduct to the houses in the town by means of mains and service pipes. The *mains* are made of cast or spun iron or steel, and are coated inside with a coal tar preparation or spun concrete or bitumen to prevent the water from rusting them. Asbestos cement pipes are also used. The *service pipes,* which carry the water from the mains into the houses, are made usually of lead or wrought iron. Water which has passed through lead service pipes may cause lead poisoning in consumers. Iron service pipes should be coated with a coal tar preparation or galvanized.

On the Constant System the water is under constant pressure so that it is always available. On the Intermittent System it is turned on, say, for an hour twice a day so that houses are rationed up to the capacity of their cisterns. On the Dual Supply System there are two sets of mains and service pipes, one set supplying pure water for drinking and cooking, and the other a lower-grade water for washing and scrubbing.

Where a supply is pure and adequate the constant system is the rule.

WATER-BORNE DISEASE

The diseases communicable to man by the drinking of water may be caused by either (1) inanimate matter in solution or suspension or (2) micro-organisms present in the water. A number of the vector infections and metazoan infestations of man include an aquatic stage in the life history of the vector or parasite but do not as a rule involve the drinking of the water. They are referred to elsewhere.

Inanimate Matter. Moorland waters may be charged with vegetable extracts from marshy or peaty soil. Other waters may carry finely divided clay in suspension, as happens with some American rivers. Some deep waters have naturally a high content of sodium chloride, and wells at the coast may become brackish through invasion by the sea. Hardness too may be a marked feature of water from certain strata. The above-mentioned types of water may habitually or on occasion give rise to digestive disturbances ranging from minor dyspepsia to purging. Waters mainly from deep wells bored in bauxite, natural phosphate or other strata may contain fluorine which causes in children dental dystrophy with mottled enamel of the teeth. Certain waters passing through lead service pipes may take up the metal and, as at Sheffield in 1887, cause lead poisoning.

Micro-organisms. The outstanding specific water-borne disease is cholera. In the Hamburg outbreak of 1892, caused by unfiltered river water, 8605 persons died between mid-August and mid-October. Typhoid fever also is easily spread by water. Maidstone in 1897 had 800 cases, ascribed to polluted springs. The water-borne outbreak of 310 cases at Croydon in 1937 was attributed to a worker in an adit who proved to be a carrier of *B. typhosus*. Both the amoebic and the bacillary forms of dysentery may be water-carried and the transmission of Weil's disease, or infective jaundice, is aided by water. Founded on studies of its virus, the suggestion has been advanced that poliomyelitis can be water-borne.

CHARACTERS OF WATER

The physical, chemical and bacteriological characters of water may, when necessary, be explored with elaboration for domestic, trade or other purposes. Reference will be made here mainly to points bearing on the water-conveyed diseases.

Colour. A brown colour is common in peaty waters. It may be accompanied by an acid reaction. If so, the water is likely to attack lead pipes. Peat brown can be completely removed from water by means of mechanical filtration.

Turbidity. Waters which are constantly turbid may be innocuous. Intermittent turbidity, showing after rain in a shallow well usually clear, indicates that the well is open to surface pollution and therefore unsafe.

Odour. Lake and reservoir waters in which algae are abundant may be tainted by essential oils freed at the death or disintegration of these organisms. The odours are described as aromatic, grassy, or fishy.

Other sources of odour in water are the bitumen, tar, or other coatings of new mains.

Taste. Common salt in deep wells or wells invaded by the sea can be tasted by most people at 60 parts of chlorine per 100,000. In waters normally salt free the presence of chlorine above a specified figure suggests contamination by sewage, the reason being that urine contains 0·5 per cent. of combined chlorine.

Hardness is that quality of water in virtue of which it produces with soap an insoluble curd instead of a soft lather. Hard soap consists chiefly of sodium stearate, $C_{17}H_{35}COONa$, and soft soap of potassium oleate, $C_{17}H_{33}COOK$. Hardness in natural waters is mainly caused by soluble salts of calcium and magnesium. Temporary hardness is due to the bicarbonates of these metals. When the water is boiled, CO_2 is driven off and the salts are thrown down as carbonates. Permanent hardness is unaffected by boiling. It is principally due to the soluble sulphates, chlorides and nitrates of calcium and magnesium. Total hardness is the sum of temporary and permanent hardness. One degree of hardness is equivalent to one part of $CaCO_3$ in 100,000 parts of water. Hardness up to 10° means a soft water: over 10° medium: over 20° hard: and over 30° very hard. Rain and upland waters are soft: rivers range from soft to hard: springs and wells are hard. Hardness in water produces fur in kettles and scale in boilers. The curd of hardness adheres to the skin and clings firmly to wash basins. Linen in the wash needs severe rubbing and discolours under the iron. In cooking, the green of vegetables is discharged and the fibre of meat toughened. Dietetically hardness in water may cause digestive derangement but tolerance is usually established. For domestic and industrial purposes high temporary is less inconvenient than high permanent hardness.

Lead in water is usually derived from the lead pipes through which it passes. The plumbosolvent action of upland waters from peaty sources is greatest in autumn owing to the concentrated acids which they contain at that season. Other waters, while they react with lead, take little or none of the metal into solution and so do not cause lead poisoning. Most hard waters form insoluble salts which are precipitated *in situ.* Hard waters however with a high nitrate content may be actively plumbosolvent. Silicated waters form insoluble silicates. Waters containing carbon dioxide produce basic lead carbonate $PbCO_3 . Pb(OH)_2$, which is a comparatively insoluble salt, but if carbon dioxide is present in excess the basic carbonate is redissolved and poisoning may result. Pure acid-free waters coat the lead with an insoluble precipitate of $Pb(OH)_2.PbO$. They do not usually cause poisoning. To prevent the solution of lead the acid feeders of moorland waters may be intercepted and excluded from supply, or the whole supply may be neutralised with $Ca(OH)_2$ or Na_2CO_3, or silicated with Na_4SiO_4. Also lead service pipes may be replaced by cast iron. 0·1 part of lead per million of water is probably harmless: 1·0 part per million is too much. Between these two limits it is debatable land.

Metallic poisoning credibly ascribed to the presence of copper, iron, zinc, manganese or aluminium in water has not been recorded, but water which has been led through copper service pipes, especially those of the household hot water supply, if used for washing textiles, may carry copper enough to combine with soap derivatives and dye white fabrics green.

TESTING OF WATER

A sample[1] of water for chemical analysis should be collected in a glass-stoppered Winchester quart bottle, which holds sufficient water for a complete examination. The bottle used should have been cleansed with strong hydrochloric acid and then thoroughly rinsed with distilled water. A bottle which has contained ammonia should not be employed. The sample taken should as far as possible be representative of the water. If a sample from the main is required the tap should be run full for five minutes before sampling. If the presence of lead is suspected, the first runnings in the morning should be caught. The stopper of the bottle should be secured by tying a piece of linen over it, and the bottle duly sealed. Samples for bacteriological examination should be collected in glass-stoppered, 8-ounce bottles which have been sterilised for 30 minutes by dry heat and sent to the laboratory in the apparatus shown in Fig. 75. Before sampling from a domestic tap, the tap should be flamed. The bottles, appropriately labelled, should be packed in ice for transport to the laboratory. The labels attached to water samples should include an exact identification of the source of the sample, the date and hour of its collection, the nature of the examination required, and the meteorological conditions prevailing at the time.

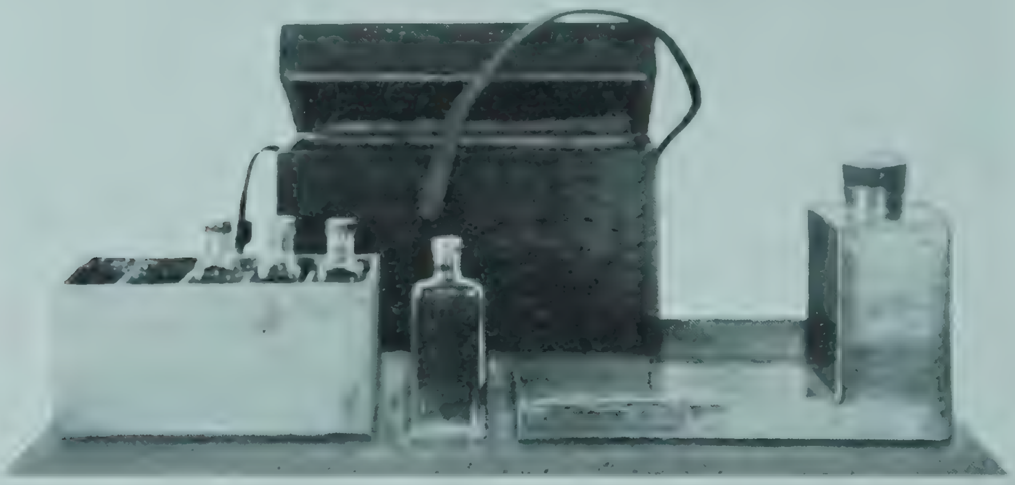

Fig. 75.—Bacteriological Water-Sampling Box.

The sample bottles are placed in the felt-lined wooden rack (*l*). The rack is then set upon the horizontal limb of the L-tank (*r*), which contains crushed ice. The whole is transported in the wooden carrying case with strap handle.

Questions as to the infectivity of water arise in this country mainly in connection with typhoid fever. As the typhoid bacillus, even with the use of the latest methods, is difficult to demonstrate in water supplies, we have in most cases to be content with presumptive instead of direct evidence. We presume that B. typhosus is usually present in sewage. If therefore sewage can be seen entering a water or, failing the ocular proof, if the water responds to tests for the admixture of sewage, we assume the presence of B. typhosus, and the infectivity of the water.

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[1] For details of water analysis see 'Laboratory Practice,' J. R. Currie: 1936.

Chemical Tests

Chemical tests for the presence of sewage in water include the testing of the water for chloride, ammonia, nitrate and nitrite. Chloride 0·5 per cent. occurs in urine. Ammonia proceeds from urea, which constitutes 2 per cent. of urine. Nitrate and nitrite are derived from ammonia. The maximum permissible quantity of each is commonly stated in parts per 100,000 of water.

Chlorine occurs in most natural waters, originating from geological strata or the proximity of the sea. This natural chlorine, which is the local normal, is allowed for in the test. The permissible figure for chlorine works out as not more than 1 part per 100,000 above a moderate local normal.

Ammonia. Two kinds of ammonia are estimated and two standards used, one for general supplies and one for uplands. The permissible figures are as shown:

	Parts per 100,000.	
	General Supplies.	Upland Supplies.
Free and Saline Ammonia:	Not more than 0·005:	Not more than 0·002.
Albuminoid Ammonia:	Not more than 0·01 :	Not more than 0·005.

High free and saline ammonia with low albuminoid may come from a geological stratum, while low free and saline ammonia with high albuminoid may be of vegetable origin. A high figure for both kinds of ammonia suggests the admixture of sewage.

Nitrate, like chloride, may proceed from geological strata and allowance must therefore be made for a local normal. The permissible figure is not more than 1 part per 100,000 above a moderate local normal.

Nitrite usually implies active or recent pollution, and a trace condemns. Exceptionally, nitrite may appear in deep well waters owing to the reduction of nitrate by contact with metal pipes or fittings.

Other chemical tests for water are as under:

Dissolved Oxygen. Tap water usually contains about one part of dissolved oxygen per 100,000. The amount present in a given sample should not be less than 0·5.

Oxygen Absorbed. Potable waters in general should not absorb more than 0·15 part of oxygen per 100,000, though upland waters containing peaty derivatives may range from 0·3 to 3 per 100,000. A sample which absorbs 0·05 part per 100,000 or less is of a pure type. Complete reliance, however, should not be placed on the oxygen absorption test alone.

Iron occurs in most natural waters and ground waters may be heavily charged. The iron of piped supplies, however, is usually derived from rusted pipes. The quantity of iron in a water sample should not exceed 0·05 part per 100,000.

Copper, which may on occasion proceed from copper service piping, should not exceed 0·1 part per 100,000.

Zinc from galvanised pipes has been present in water up to 3 parts per 100,000 without causing illness. A limit of 0·5 part per 100,000 has, however, been recommended.

Arsenic should be absent from drinking water.

TABLE 33.
CHEMICAL WATER STANDARDS

Parts per 100,000

	NOT MORE THAN	
Chlorine	1.0	Above moderate local normal.
Hardness	30.0	...
Ammonia:		
Free and Saline	0.002 to 0.005	...
Albuminoid	0.005 to 0.01	...
Nitrite	0.0	...
Nitrate	0.1	Above moderate local normal.
Dissolved Oxygen	...	1.0 is normal.
Oxygen Absorbed	0.15	Higher in peaty waters.
Poisonous Metals:		
Iron	0.05	...
Lead	*0.1*	*Per million.*
Copper	0.1	...
Zinc	0.5	...
Arsenic	0.0	...

TABLE 34.
SUNDRY WATER ANALYSES

Parts per 100,000

	Deep Well	Deep Well: *Casing Weak*	Surface Water	Shallow Well *New*	Spring	Well: *After Rain*
Chlorine	22·0	29·0	2·2	10·7	3·0	3·4
Hardness	5	15	2	17	10	9
Nitrate	0·13	0·12	0·3	0·1	0·6	0·9
Nitrite	0	*trace*	0	0	0	0
Free Ammonia	0·020	0·050	0·004	0·020	0·008	0·018
Albuminoid Ammonia	0·005	0·002	0·015	0·023	0·007	0·120
Oxygen Absorbed	0·080	0·120	0·210		0·122	
Opinion	Safe	Unsafe	oubtful	Safe	Safe	Unsafe

Field Work

A rapid yet comprehensive method of qualitative water analysis is set forth in the undernoted Table. The apparatus required is of the simplest and many of the reagents are obtainable in tabloid or ampoule form.

TABLE 35.

QUALITATIVE WATER ANALYSIS

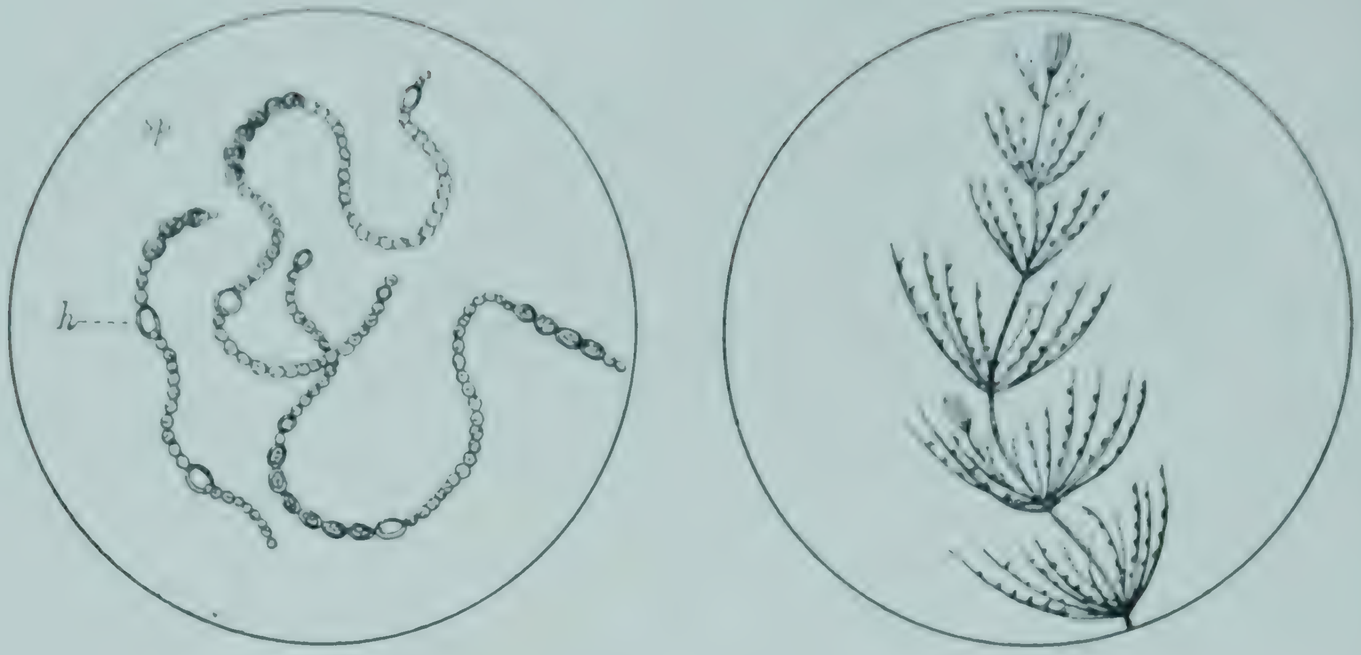
Field Tests

Ammonia . . .	Add 2 cc. Nessler's Reagent. Ammonia gives a brown tint.
Nitrate . . .	Add an equal quantity of Brucine solution (1 in 1000). Run concentrated H_2SO_4 down side of test tube so that a layer forms at the bottom. Shake *gently.* The appearance of a pink ring indicates the presence of nitrate.
Nitrite . . .	Add a few drops of Ilosvay's Reagent. A pink colour developing rather slowly indicates the presence of nitrite.
Chlorine . . .	Acidify faintly with dilute HNO_3. Add silver nitrate. A white precipitate indicates chlorine.
Lime	Add ammonium oxalate. A white precipitate soluble in HCl indicates lime.
Sulphate . . .	Add HCl and barium chloride. A white precipitate insoluble in dilute acids indicates sulphate. Very small amounts of sulphate may require heat to bring down the precipitate.
Phosphate . . .	Add 2 drops HNO_3 and an excess of ammonium molybdate. Boil. A yellow precipitate soluble in ammonia indicates phosphate.

Bacteriological Tests

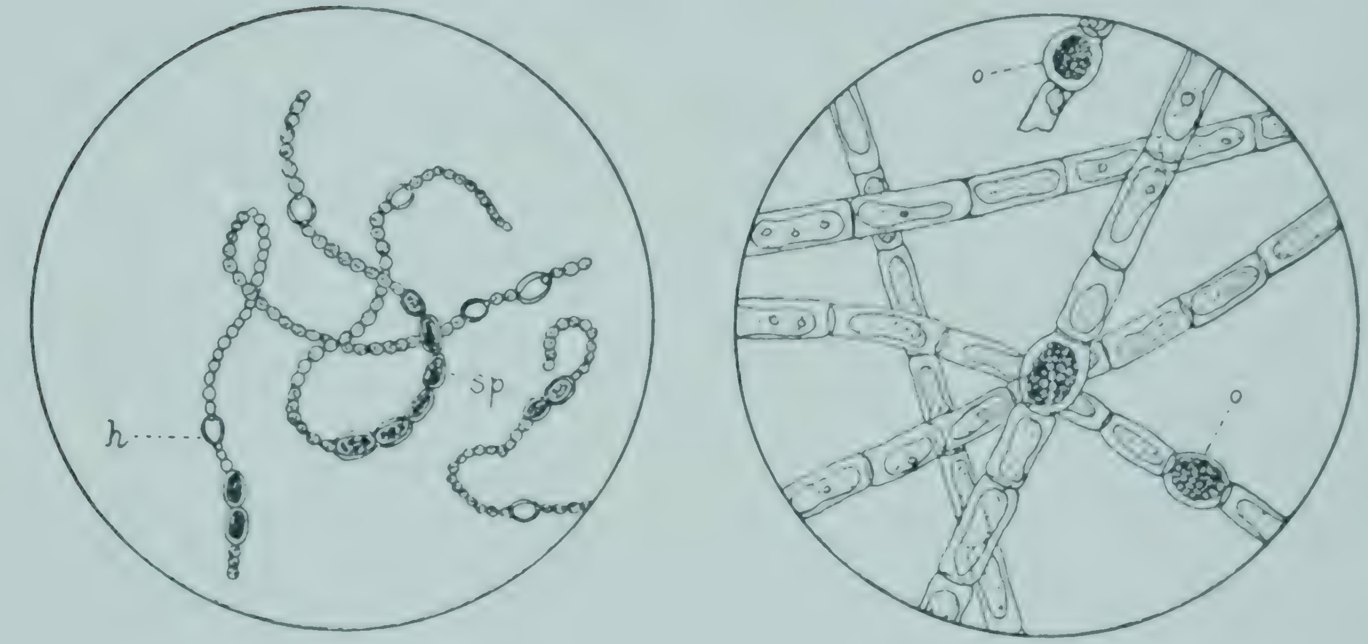
Bacteriological tests for the presence of sewage in water may for practical purposes be narrowed down to the *Bacillus coli* test. The normal, but not exclusive, habitat of this organism is the mammalian intestine. It is abundant in human faeces and therefore also in sewage, the latter of which may contain up to 100,000 *B. coli* per ml. Its occurrence in a water in adequate numbers suggests the admixture of sewage.

In British waters of the first grade, *B. coli* can be kept absent from 100 ml. of water in 100 per cent. of samples. With other good waters 90 to 95 per cent. of samples may be *B. coli* free. With still others, also good, *B. coli* absent from 50 ml. samples may be accepted as adequate. For small country supplies standards may be lower, but not lower than *B. coli* absent from 20 ml. The appearance of *B. coli* in 10 ml. or less



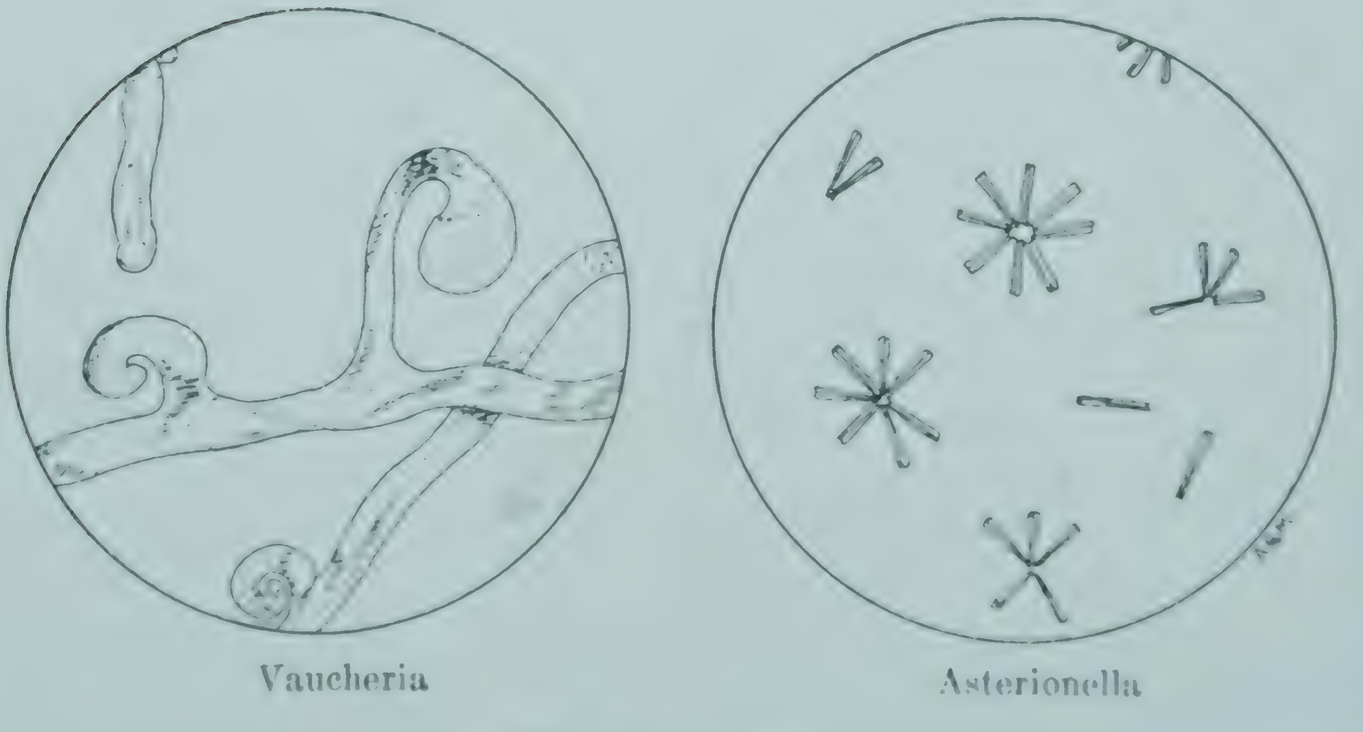
Anabaena

Chara



Nostoc

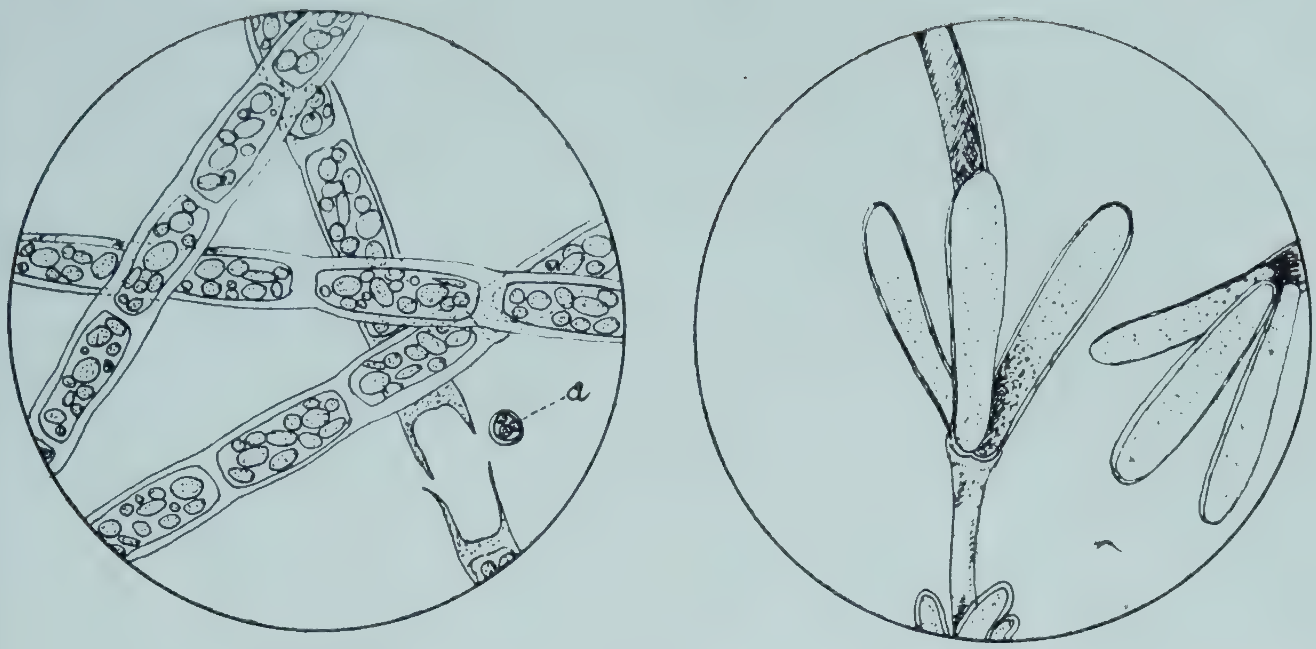
Oedogonium



Vaucheria

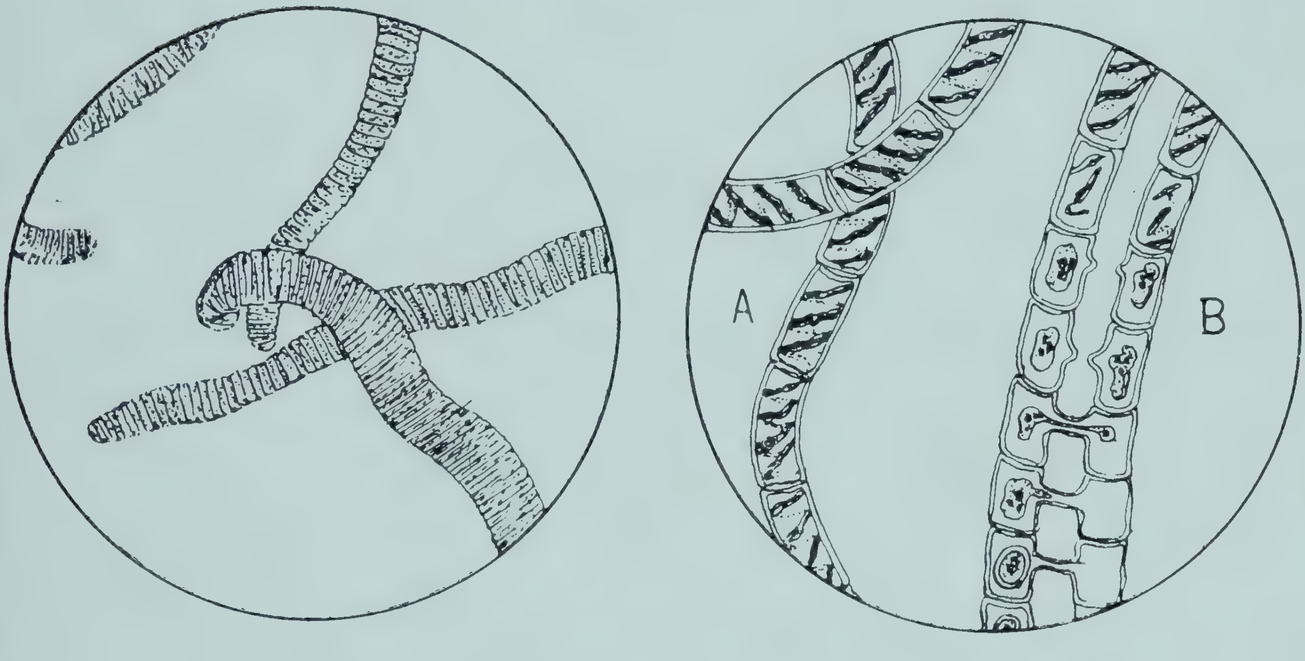
Asterionella

Fig. 76.—Algae.
Variously magnified.
sp. = spore. *h* = heterocyst. *o* = oogonium.



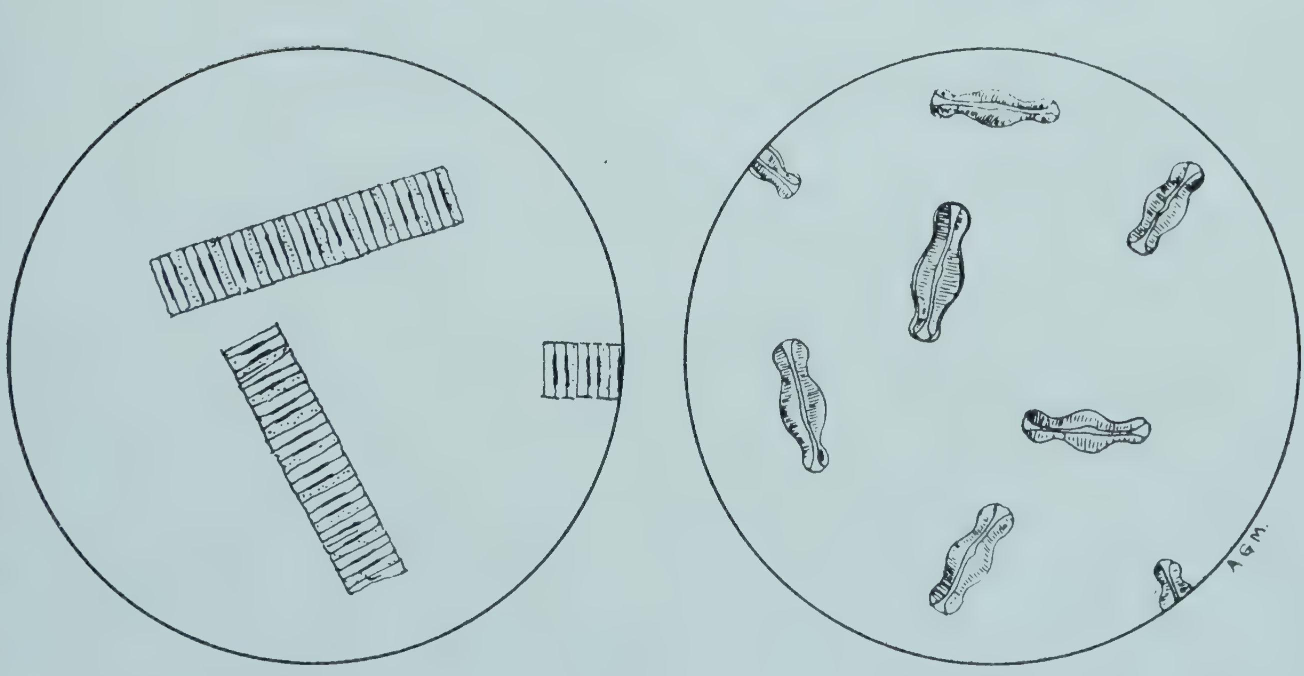
Conferva

Nitella



Oscillatoria

Spirogyra



Fragillaria

Gomphonema

Fig. 77.—Algae.

Variously magnified.

a = aplanospore. *A* = vegetative form. *B* = Conjugation.

of any reputable water points to contamination and calls for immediate action.

A more expeditious but, for routine work, sufficiently accurate method is to use as the test organism not typical *B. coli* but the coli-aerogenes group of which *B. coli* is a member. Any error involved in the change over from the *B. coli* test to the coli-aerogenes test, known also as the presumptive coli test and the coliform test, is on the side of safety.

Further, a formula has been devised and tables drawn up which enable the coli-aerogenes finding to be stated, not on a 'present or absent' basis, but as the 'probable number' of coli-aerogenes organisms in 100 ml. of the water examined. On this plan a probable number under 3 specifies a high grade water.

Confirmatory evidence of the presence of sewage in water is furnished by the demonstration of *Streptococcus faecalis* and *Clostridium welchii.*

Ice

Ice, whether natural or artificial, carries the chemical and bacteriological impurities of its liquid original. The analysis is conducted as in the case of drinking water. The superficial layers of the ice are the most likely to be contaminated. Chemical examination of ice creams is rarely required, but bacteriological reports are frequently requested since enteric and dysentery organisms may live for some time in these products.

Aerated Waters

The cheaper grades of aerated drinks are simply tap water charged with carbon dioxide under pressure. Good class soda water may contain sodium bicarbonate up to 10 grains per pint. It is important in examining aerated waters to test for the presence of poisonous metals. Both zinc and lead have been found, presumably derived from the filling plant or from the metal fittings of siphons. Bacterial counts are usually minimal owing to the high content of carbon dioxide.

Sea Water

Occasionally it is desired to ascertain the chemical characters of sea water in which shell-fish layings occur. The analysis presents difficulties of interpretation since the figures for chlorine and oxygen absorbed, always high in sea water, offer no assistance. The presence of phosphate, which is normally absent, is strongly suggestive of animal pollution. Phosphate may be tested for by evaporating 100 cc. of the acidified sample to dryness, filtering the residue dissolved in concentrated nitric acid, and testing the filtrate with ammonium molybdate, which shows yellow in the presence of phosphate. Bacteriological examination of the sea water should always control the chemical findings.

PURIFICATION OF WATER

STORAGE. The storage of water in reservoirs and lakes discharges its colour and reduces its bacterial content. If typhoid bacilli gain access to stored water, the great majority die out within a week and all are usually dead in a month. The seasonal overgrowth of algae and diatoms (Figs. 76 and 77) in stored water, besides communicating to the water unwished-for odours, may render the further disservice of clogging sand filters. Remedial action consists not so much in killing off the algae as in controlling their excessive proliferation. For this purpose 0·5 to 1 part of copper sulphate per million is usually sufficient. With a view to the even distribution of the salt over the whole surface of large reservoirs various methods have been devised, but the original expedient of towing a sack containing crystalline copper sulphate astern of a boat fitted with an outboard motor from side to side of the reservoir until the whole area has been covered seems as good as any. Other useful algicides are chlorine, chloramine, cuprichloramine, and activated carbon. All algicides should be applied with discretion, for the protection of fish.

Slow Sand Filtration. The filter consists of a shallow concrete tank (Fig. 78) containing graded layers of sand and gravel over a layer of broken rock. The water gravitates through the sand and is led away in under-drains. The purification process is biological. On the surface of the topmost layer of sand the water throws down its diatoms and algae, which grow together into an adhesive film and arrest the bacteria. After a time, as the film thickens, it offers too much resistance to the water. The sand which carries it is then scraped off, washed and replaced, and the filter started afresh. The normal rate of filtration per day is 50 gallons per square foot or 2,000,000 gallons per acre.

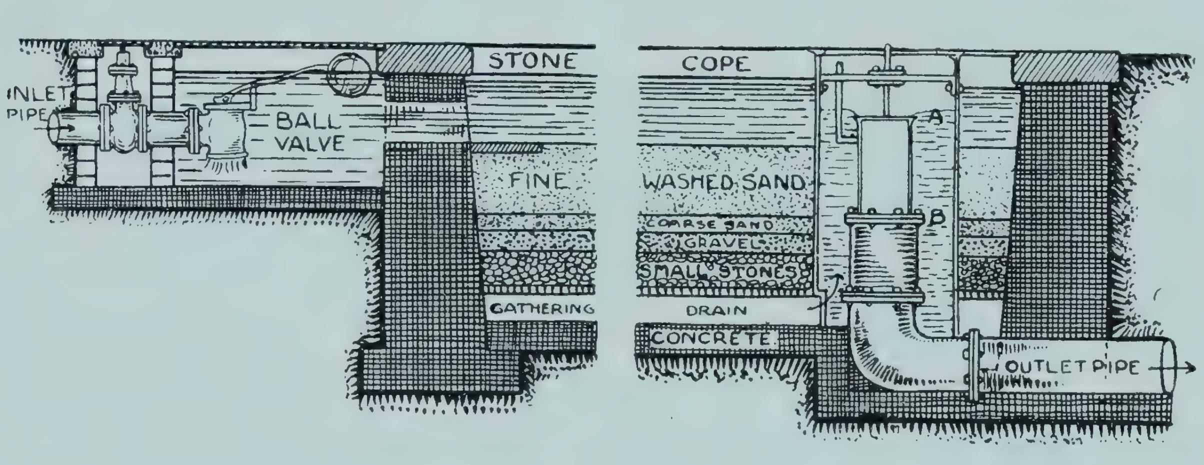


Fig. 78.—Slow Sand Filter. The telescopic Head Piece, which controls delivery, can be lowered from A to B.

Mechanical Filtration. In the gravity type the filtering medium is sharp sand or crushed quartz, and 'filter alum,' a crude aluminium sulphate, is added to the water. This salt reacting with lime, either present or added, forms the colloidal $Al_2(OH)_6$, which entangles the bacteria present in the water and is deposited with them as a gelatinous film on the surface of the sand. The normal rate of filtration per day is 3000 gallons per square foot or 130,000,000 gallons per acre. The pressure type (Fig. 79) of mechanical filter is a closed steel or reinforced concrete chamber in which the water is driven through a special medium under pressure. Both types are washed clean by means of compressed air jets or a reverse stream of filtered water.

Chlorine Gas. Chlorine is supplied in liquid form under pressure in steel cylinders, from which it is led off for use through flexible metal piping. Dosage is regulated by means of chlorinators which are either manually controlled or automatically adjusted by reference to the Venturi meter or a photo-electric cell. Chlorine may be applied before filtration or after filtration or both before and after. In London lately the dose for filtered Thames water was 0·25 part per million. For clear water of high initial purity 0·1 part per million may suffice. For waters which show colour or turbidity of organic origin 1 to 2 parts per million may be necessary. Dosage should be so regulated that 0·1 part of free residual chlorine can be demonstrated in the water after 30 minutes contact. The test for residual chlorine is made with *o*-tolidin, which strikes a characteristic yellow with the free chlorine present.

Tastes which occur in chlorinated waters give rise at times to complaint. They are of two kinds: (1) the taste of chlorine itself, which can usually be controlled by accurate dosing, and (2) a by-product taste, which is more intractable. The by-product taste, which resembles that of iodoform, is produced by the combination of chlorine in the water with substitution products of the benzene series derived from such sources as smoke-fogs, tarred road washings and industrial waste. Clear waters exhibit more by-product taste than coloured waters. The ammonia in the latter binds the chlorine as chloramine. In the chlorinated water of London A. C. Houston prevented both kinds of taste by excess chlorine followed by dechlorination with potassium permanganate or an ammonium salt.

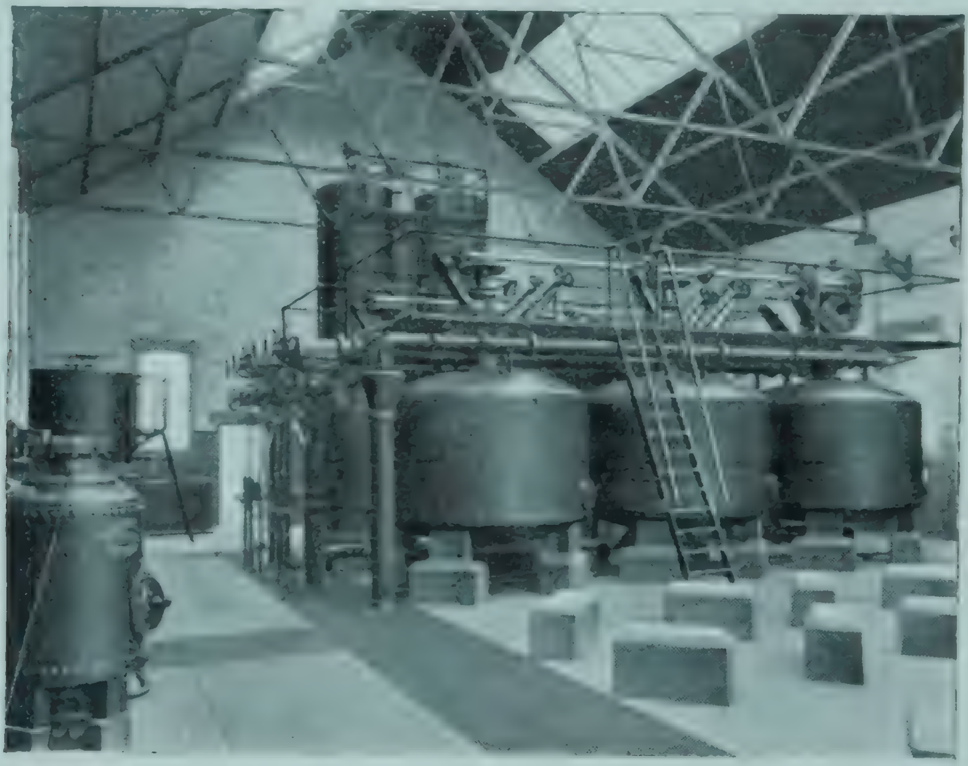


Fig. 79.—Pressure Filters.

Chloramine. Chlorine is now being applied after previous dosage of the water with ammonia, forming the substitution ammonia chloramine, NH_2Cl, which is a vigorous germicide and more persistent than chlorine alone.

Bleaching Powder or 'chlorinated lime,' having the approximate formula $Ca(OH)_2.2Ca(OCl)Cl$, contains 33 per cent. of available chlorine. It is employed by troops in the field and is useful also in civil life for emergency water purification.

Excess Lime is good for the bacterial purification of hard waters. In the method as now practised the total water for treatment is divided into a large and a smaller fraction. The large fraction is dosed with aluminium sulphate and the smaller with enough cream of lime to give excess lime of 2 parts per 100,000 in the total water. The two fractions are now mixed by agitation, and permitted to sediment for 24 hours. The excess lime in the total water is then carbonated by injecting carbon dioxide, after which the water is filtered, treated with activated carbon, and finally passed to the service reservoir for distribution.

Activated Carbon is a special charcoal of high porosity, procurable either as a powder or in granular form. It is applied to waters for the purpose of improving their appearance and palatability.

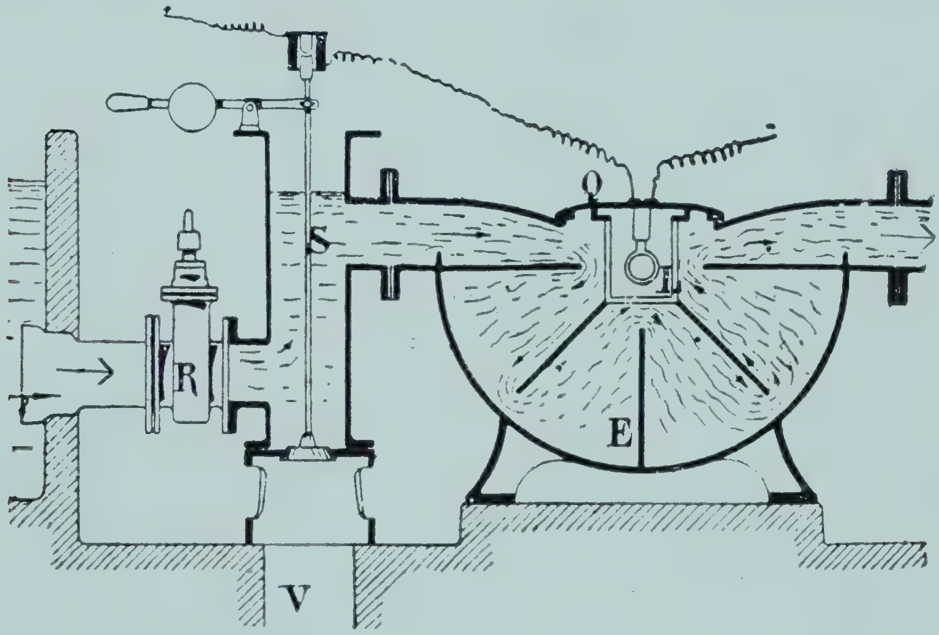


Fig. 80.—Ultra-Violet Ray Sterilisation of Water.
R Supply Valve. V Deviation Valve. S Solenoid.
E Baffle Plate. L Lamp.

The powdered carbon suspended in water is fed at a constant rate to the water undergoing treatment, which is finally passed through a rapid sand filter. The granular carbon is enclosed as a layer in the sand filter, and makes contact with the water undergoing treatment as it filters through.

In its powdered form activated carbon has proved a most efficient agent for the removal of odours from water. The grassy or fishy odours contributed by algae, and the earthy odours which may result from the excess lime process, are alike dispelled by its application, while the flat insipid waters of rivers and reservoirs, when subjected to its influence, develop sparkle and become stimulating to the palate. The substance in its granular state, though less used than the powder, is one of the recognised agents for dechlorination.

Ozone for the ozonisation of water is prepared by passing the silent electric discharge through cold, dry air. The ozonised air is bubbled through the water in a tall tower. With clear water and in skilled hands the method gives good results. The normal dose is 2 parts of ozone per million.

KATADYN SILVER precipitated on sand from silver oxide Ag_2O by the action of formaldehyde renders water filtered through the sand sterile in ½ to 1 hour, and also makes it capable of handing on its germicidal powers to further quantities of water. The process is termed oligodynamic as the concentration of silver in the water is of the order of 100 γ or less per litre. The electrically charged silver ions are presumed to be the effective agents. The method is good for clear water only.

IRRADIATION. The ultra-violet rays are actively bactericidal in clear water. The sterilising chamber is fitted with baffle plates which cause the water to pass close to the mercury vapour lamp. A solenoid driven by the current opens a deviation valve if the lamp goes out, so that no unsterilised water can enter supply (Fig. 80).

SOFTENING. (1) To reduce temporary hardness in water fresh $Ca(OH)_2$ is added. It combines with CO_2 to form $CaCO_3$ and concurrently throws down most of the $CaCO_3$ previously held by the CO_2 in solution as bicarbonate. (2) To reduce both temporary and permanent hardness, when the temporary hardness equals the permanent, NaOH is added to the water equivalent to the permanent hardness. The NaOH by forming $Ca(OH)_2$ reduces the permanent hardness, and the $Ca(OH)_2$ so formed reacts with the temporary hardness. If the temporary hardness exceeds the permanent the further addition of $Ca(OH)_2$ reacts with the remainder of the temporary hardness. (3) To reduce both temporary and permanent hardness, when the permanent hardness due to lime exceeds the temporary hardness, Na_2CO_3 is added equivalent to the permanent hardness and $Ca(OH)_2$ equivalent to the temporary hardness.

ZEOLITES, through their property of base-exchange, are useful softeners of water. These salts, of which an example is natrolite, $Na_2O.Al_2O_3.3SiO_2.2H_2O$, are hydrated silicates of aluminium, which have the faculty, when combined with an alkali metal base, of exchanging it for calcium and *vice versa*. A sodium zeolite in a hard water containing calcium sulphate takes up calcium and liberates sodium and so softens the water. When all its sodium has been given up the zeolite is exhausted. It can be revived by dosing it with a 10 per cent. solution of sodium chloride. The zeolite method is effective both on the domestic scale and for industrial and general supply. Synthetic zeolites are more active than the native form, but more fragile. 'Permutit,' a well-known base-exchange softener, is a synthetic zeolite which has the formula $Na_2Al_2Si_2O_8$. Its action upon a hard water may be represented as follows:

$$Na_2\,Al_2\,Si_2\,O_8 + Ca\,SO_4 \rightarrow Ca\,Al_2\,Si_2\,O_8 + Na_2\,SO_4$$

Regeneration

$$Ca\,Al_2\,Si_2\,O_8 + 2Na\,Cl \rightarrow Na_2\,Al_2\,Si_2\,O_8 + Ca\,Cl_2$$

Carbonaceous zeolites prepared from coal or peat are also used. Zeolite apparatus is obtainable in sizes which vary from the small domestic model to that suitable for a large hotel.

PURIFICATION OF MAINS

If, in emergency, damage befalls at a point or points of a water supply system, surface water or sewage may make its way into the mains. If so, after the break or breaks have been repaired and before the system is permitted to resume its normal functions, the mains should be sterilised by charging them with heavily chlorinated water. If time permits and contact can be maintained for several hours, doses of chlorine from 10 to 50 parts per million may be sufficient. If time fails and contact for only, say, an hour is possible, the dosage may range from 50 to 100 parts per million. The sources of chlorine for the purpose may be either (1) Liquid Chlorine, (2) ‘Chloros’ or other hypochlorite, or (3) Bleaching Powder.

Liquid Chlorine, assuming a mobile chlorinator, is the most convenient to apply and at the same time the most effective.

‘Chloros,’ given a hypochlorinator, is convenient to apply, but its deterioration in storage is often so rapid that its bactericidal power on the occasion may be open to question.

Bleaching Powder, though unhandy to apply, is perhaps the most likely to be available in quantity. Its efficiency as a sterilising agent is however lowered by its comparative alkalinity and by its depositing calcium carbonate on surfaces, which protects bacteria. For use in mains, the powder should be made up into a smooth cream with water, and either run into the main as it fills or else poured into the main before admitting its charge of water. Wherever possible, on the conclusion of the contact period, the charge should be tested for residual chlorine before being run to waste.

DOMESTIC PURIFICATION

The domestic purification of water laid on to houses should not be required in a well-organised community. Under special conditions, for example in camps or when travelling, it may be desirable or necessary.

Boiling. Momentary exposure to 212° F. suffices to kill all non-sporing bacteria including *B. typhosus,* but drives off the dissolved gases, rendering the water flat. Re-aeration may be effected by ‘tossing’ the water between two jugs. In partial boiling three-quarters of the water is brought to the boiling point and the remaining quarter immediately added. This method retains some of the gases. The water is safe to drink in five minutes.

Bleaching Powder may be used on the domestic scale. A level teaspoonful of bleaching powder is rubbed into a teacupful of water. This solution is diluted with three teacupfuls of water, and one teaspoonful of the dilution is put into each

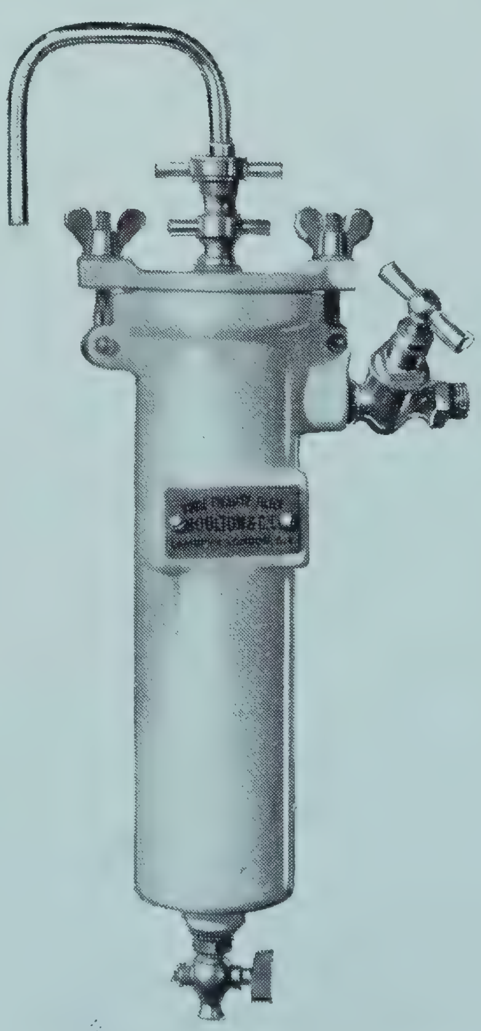


Fig. 81.—Domestic Filter: Berkefeld Type.

2-gallon bucket of drinking water. The concentration of chlorine is 0·4 to 0·5 part per million, which is rather a heavy dose, but the water is safe to drink in 15 minutes.

HYPOCHLORITE. Solutions of sodium hypochlorite such as Milton, prepared electrically, are now available for domestic purification of water.

PASTEUR-CHAMBERLAND FILTER. This filter consists of a bougie of unglazed porcelain enclosed in a metal case which can be attached to a household tap. A portable pump to drive the water through may be carried by travellers. The bougie is impervious to *B. typhosus* but its pores clog after three days' use. It is then taken out, scrubbed with a hard brush, and replaced.

BERKEFELD FILTER. This type (Fig. 81) has a bougie of kieselguhr, a diatomaceous earth. Its delivery is more rapid than that of the Pasteur-Chamberland filter, but *B. typhosus*, as was shown by Colonel Horrocks, can grow through in from 4 to 11 days. Every three days the bougie should be taken out, scalded in boiling water and replaced.

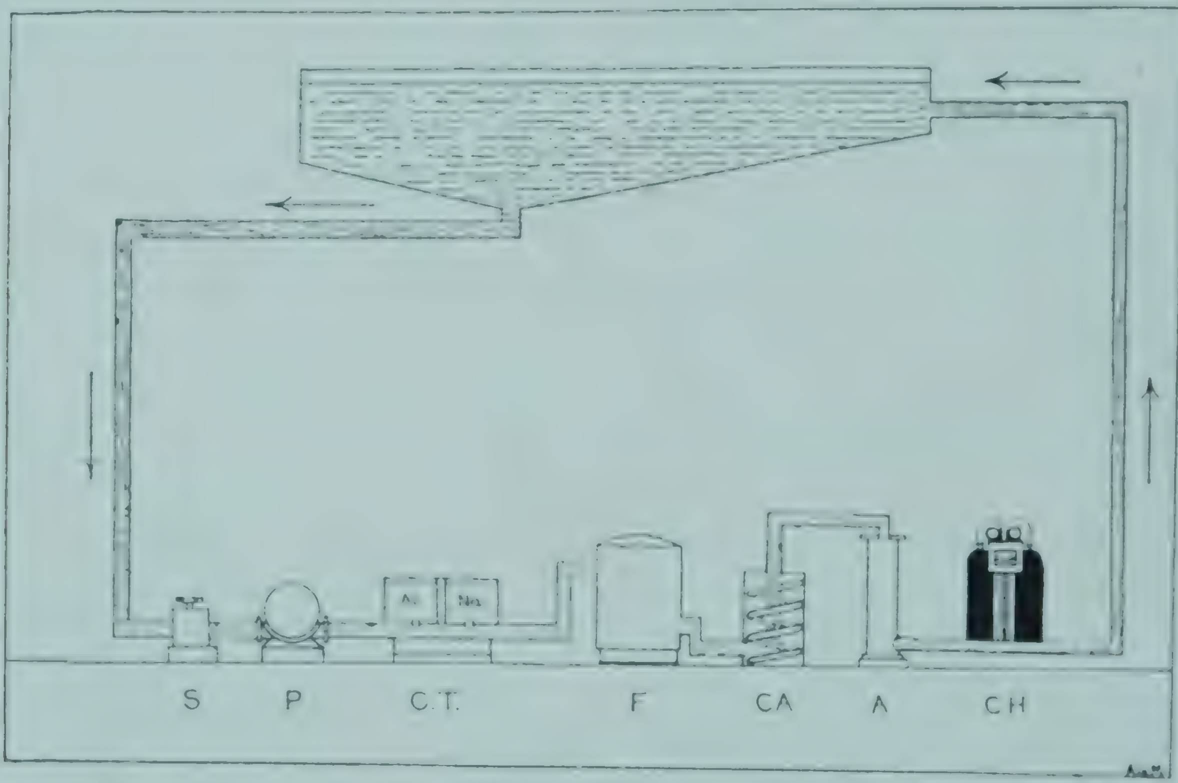


Fig. 82.—Swimming Bath: Continuous Re-circulation.
S Strainer box. P Pump. CT Coagulation tanks. F Filter.
CA Calorifier. A Aerator. CH Chloraminator.

SWIMMING BATHS

The original simple plan of changing the water of swimming baths by 'fill and draw' has now been superseded by continuous re-circulation usually on a 4-hourly basis (Fig. 82). The water, taken out at the distal end of the pond, is first screened: then dosed with filter alum and soda: then passed through a mechanical pressure filter at the rate of 125 gallons or so per square foot per hour: then aerated: then warmed where necessary to, say, 72° F.: then dosed with chlorine and finally returned to the pond at the proximal end. The dose of chlorine should be sufficient to maintain a concentration of 0·2 to 0·5 per million parts of the water. A concentration above 0·5 is apt to make the eyes of the bathers smart. In order to check odours of chlorine the water, before chlorination, should be kept slightly alkaline. At the beginning of the bathing season it may be useful to put into the water 0·1 part of ammonia per million. As the season advances the water by re-use acquires a higher ammonia content and dosage with ammonia ceases to be necessary. Still later in the season ammonia reaches excess proportions, and the chlorine must be increased so as to maintain a ratio of chlorine to ammonia of 2 to 1. Chloramine likewise may be used as the disinfectant or else, since the water is clear, ozone, ultra-violet irradiation or katadyn silver.

Locally ozonisation has been found satisfactory, especially in areas which enjoy a public electrical service. The gas both clarifies and enlivens the water, through which the shimmering ozone-charged bubbles can be seen rising. Overdosage should be avoided since the penetrating odour of excess ozone accumulating in the air may cause discomfort to both swimmers and spectators.

At all swimming baths the water should have good transparency, showing up the bottom and sides of ponds clearly. These surfaces should in addition be kept free of growths or deposits. Bacterially, swimming bath water should be close up to the standard for drinking water, namely, *B. coli* absent from 100 ml. As a chemical standard it has been suggested that albuminoid ammonia should not exceed 0·025 part per 100,000. If overgrowth of algae threatens, the water should be dosed for a few days with 1 or 2 parts of copper sulphate per million.

Persons suffering from ear conditions should bathe with circumspection. A specialist examining a series of acute ear cases whose illnesses had been ascribed to bathing found that all but one had a preceding aural lesion. The risks to people in normal health who frequent swimming baths have usually up to the present not been from the water. In one instance it was found that bathers suffering from mycosis[1] of the foot, by walking bare-foot on the paving round the bath, made the paved surface infective to the bare feet of others. In the presence of foot mycosis all paved surfaces should be hosed with hot water, and a submerged foot-way charged with hypochlorite solution should be the only means of approach to the pond. At all swimming baths ample urinal and w.c. accommodation should be available, and there should be a channel round the pond for bathers to spit into. Also no bather should be allowed to enter the pond without a previous soaping and shower, for which adequate provision ought to be made.

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[1] Page 581.

XIV.

WASTE DISPOSAL

The waste material which requires to be removed from houses and thereafter disposed of in an appropriate manner consists of (1) Dry Refuse and (2) Sewage.

DRY REFUSE

Domestic dry refuse includes ashes, rags, paper, glassware, crockery, enamelled ware, tin plate, light iron and leather, together with garbage and kitchen waste. Stable manure, street sweepings and waste paper from shops are non-domestic dry refuse.

Collection. In country places domestic dry refuse is gathered together in ash-pits, from which it is removed from time to time as occasion offers. An ash-pit should not be nearer a dwelling house than 10 feet. In towns each house should have its own lidded ash-bin, which is cleared by the Corporation dustmen from once per day to once per week according to local standards. Sacks for the collection of waste paper are usually supplied. The refuse should be conveyed to the place of its disposal in a covered motor dust cart. The average dry refuse of a British town is 5 cwt. per head per annum. In Glasgow lately the figure was 7 cwt., in the Manhattan district of New York 1 ton.

Disposal. Mass Tipping has fallen from credit. In Regulated or Controlled Tipping, now in favour, the refuse is put down in layers 5 feet thick and each layer covered with a dressing of 1 foot of earth at the time of deposit. Tins and other hollow ware should be crushed or removed before the refuse is buried. The tip should be rendered vermin-proof by appropriate fencing, and the breeding of flies, crickets and other pests prevented by spraying the tipping face with creosote or gammexane. Land Reclamation is regulated tipping applied to fill in hollows or recover land from the sea.

Incineration means burning the refuse in a destructor furnace. The destructors employed are of two types, the high temperature type and the low. The High Temperature Destructor works by forced draught at 1500° to 2000° F. It consumes 10 cwt. of refuse per square foot of grate surface per day. All odorous vapours pass through the heart of the fire and are so made inoffensive. The Low Temperature Destructor works by natural draught, consuming 5 cwt. of refuse per square foot of grate surface per day. A special coke furnace known as a fume cremator is required to burn up the odorous vapours. Prior to incineration in either type of destructor the refuse as a rule is partially sorted.

material of commercial utility being taken out with a view to sale. The furnace clinker, which is very hard, is used for concrete making and other purposes.

In Pulverisation the refuse is broken up by mechanical hammers and reduced to dust, which, thou[illegible] charged with organic matter and of manurial value, is described as dry, odourless and unattractive to flies. In Sea Disposal it is taken to sea in barges and jettisoned in open water. The discharge is timed to take place on the ebb or otherwise to suit the local currents. With an on-shore wind the floating material may be washed back to land.

In Special Sorting the material is graded through revolving screens. What remains is then tipped on a moving pickerband, from which the steel plate 'tins' are lifted by means of electro-magnets, while bottles and other articles are picked off by hand and sold for what they will fetch. 'Tins' are compressed into blocks by baling machines and delivered to iron works. The residue, burned in a destructor furnace, produces a clinker which is finally graded mechanically by passing it through an assortment of variously-meshed revolving screens.

There is also the 'Hyganic' process in which the sorted and screened refuse undergoes anaerobic bacterial fermentation in sealed cells for 7 days, and is then mechanically aerated for a similar period. The oxidised and partially dehydrated final residue may be used as manure.

SEWAGE

Sewage comprises Excreta, House Waste Water and Rain. On the *combined* system the sewers convey all three components. On the *separate* system they convey excreta and house waste water only, rain being excluded. On the *conservancy* system they convey house waste water and rain, excreta being excluded. Trade waste accompanies house waste water.

COMBINED SYSTEM

The combined system of sewage conveyance is usual now in populous places in this country. Combined sewage, in general, is made up of excretal matters, liquid and solid, together with the water which conveys them, of waste water from baths, kitchens and other domestic sources, of liquid waste from industrial processes, rain water from roofs and the surface run-off from streets and paved yards. When of domestic origin it is received in fixtures, passes by house pipes to the house drain, thence to the sewer and so to the purification plant or outfall.

Fixtures and House Pipes

Excreta. The *fixture* for excreta is the water closet, short hopper type with vertical back over a P or S trap with a 2-inch seal, made in one piece, pedestal fashion, of glazed stoneware, fire-clay or porcelain, not boxed in, and with seat hinged to lift. It is flushed by rim-flush from a 'siphonic' water cistern delivering 2 to 3 gallons per discharge through a $1\frac{1}{2}$-inch lead or galvanised iron down pipe. Flushing cisterns may now be replaced by the lever-operated Shanks or other flush valve which delivers water at pressures down to 5 lbs. per square inch. The water closet should be fixed in a compartment with at least one external wall and a window opening to the outer air. The *house pipe* for excreta is the soil pipe, $3\frac{1}{2}$ to 4 inches in diameter, made of heavy cast or spun iron coated with Angus Smith's preparation and jointed with run lead and gasket or oakum or else lead ribbon, or of drawn, milled or rolled lead with wiped joints. The soil pipe discharges direct to the house drain. A soil pipe common to water closets in vertical series is carried up full bore to the roof where, domed with wire gauze, it opens as the common soil pipe ventilator high enough to be clear of windows and chimneys. Also, where water closets in vertical series are served by a common soil pipe, an antisiphonage pipe is led off from the crown of each P or S trap to join a common antisiphonage shaft, which opens into the common soil pipe ventilator above the inlet of the highest fixture. This precaution is taken to prevent the withdrawal of water from a lower trap by the exhaust action of a discharge from above as it descends the common soil pipe. The trough or multiple closet in its various forms has one common trap and an automatic flush. Urinals, and slop-sinks in hospitals, are trapped like water closets.

House Waste Water. The principal *fixtures* for house waste water are baths, wash-hand basins, sinks, and wash tubs. The plunge bath, of vitrified earthenware or porcelain-enamelled iron, stands on supports clear of the floor and walls and is not boxed in. It supplies hot and cold water and has an overflow. Its outlet, which is large enough to permit rapid emptying, is guarded by a metal grating or equivalent device. Wash-hand basins are made of porcelain or vitrified earthenware and sinks and wash tubs of vitrified earthenware. Like baths, they are not boxed in, supply hot and cold water, have an overflow, wash tubs excepted, and are equipped with a guarded outlet. All waste water fixtures are trapped close up by a cast-lead or cast-iron P or S trap with cleansing screw. *Waste pipes* are commonly 2 inches in diameter, or larger for kitchen sinks and wash tubs, and are made of lead, or cast iron coated out and in with Angus Smith's preparation or inside with a vitreous glaze. Waste pipes may discharge direct to the house drain if precautions are taken to guard against antisiphonage. A waste pipe common to fixtures in vertical series is carried up full bore to the roof, to open, domed with wire gauze, as the common waste pipe ventilator. For a vertical series of fixtures, too, an antisiphonage system is useful: for a multiple series, as in a many-storeyed building, it is a *sine qua non.* The sink waste water of large kitchens, such as those of hotels and institutions, may be discharged into a stoneware grease gully with P or S trap, and led by a branch drain to the house drain. Stable drainage, which includes suspended solid material, is caught in a stoneware silt gully with removable metal silt bucket and led off through a P or S trap.

Rain. The *fixture* for rain is the rone or eaves gutter, semi-cylindrical in shape or of a moulded pattern, made of light cast-iron and having a semi-circumference of 4 inches and upwards according to the area of roof which it serves. The *rain pipe* or down-spout, into which the rone discharges, is of light cast-iron, usually cylindrical in shape and having a diameter of 2½ to 4 inches according to the area of roof served. The rain pipe discharges into the house drain with an underground P or S trap intervening. The run-off of rain from a paved yard or area is received in a stoneware or cast-iron gully trap with P or S bend, and led by a branch drain to the house drain.

TRAPS

A trap is a device for preventing reflux of air against the flow of a house pipe or drain. The insertion of a trap in a line of pipe is called disconnection. The siphon trap is a bend or dip in a pipe, in which water lies sufficiently deep for the crown of the pipe to be immersed in the retained water. The depth of immersion of the crown, usually 2 inches, is the seal of the trap. When both its limbs are vertical the trap is approximately S-shaped. When the inlet is vertical and the outlet horizontal, the trap is approximately P-shaped (Fig. 83). When neither inlet nor outlet is vertical, the trap is approximately U-shaped. P or S traps are for house pipes, gullies and silt traps: U traps are for house drains. In the Buchan U, or disconnecting trap (Fig. 84), the fresh air inlet F.A.I. supplies air to the drain D to replace that drawn up the soil and waste pipe ventilators by the passage of the wind across their open tops, or when they are warmed in the sun or by discharges of hot water. The flow of sewage is from the drain D towards the sewer S. The capped opening in the crown of the trap gives access for cleansing.

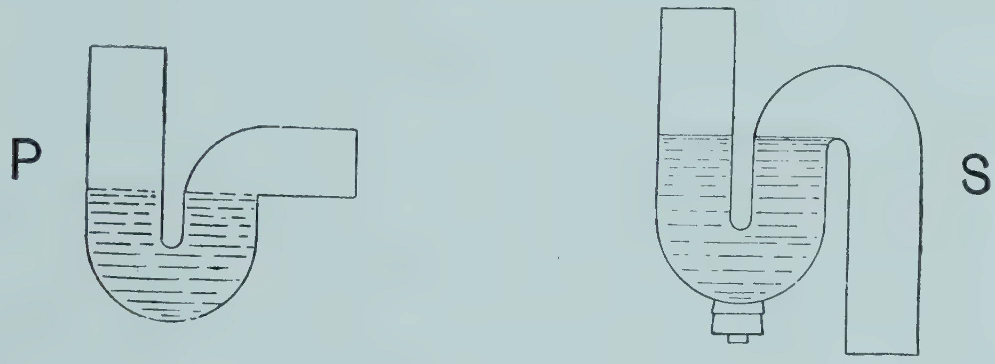

Fig. 83.—P and S Traps.

The above arrangements for house pipes are usual in Britain except that in some cases a further trap is inserted between the waste pipe and the house drain. The one-pipe system, current in North America, according to which excreta and house waste water are received into a common vertical stack, is deservedly gaining ground in this country, especially for large buildings.

HOUSE DRAINS

The house drains into which soil pipes discharge directly, and waste pipes and rain pipes through a P or S trap, are made of glazed fire-clay, stoneware jointed with tarred gasket and cement mortar or neat Portland cement, or of heavy cast iron coated with Angus Smith's preparation and jointed with lead ribbon or gasket and run lead. Stoneware drain pipes are usually made in 3-foot lengths and cast-iron drain pipes in 6 or 9 foot lengths. All have spigot and faucet joints and are laid, with the faucet looking up-stream, on a smooth hard surface with an even fall. For a 4-inch drain the fall is 1 in 40, for a 6-inch drain 1 in 60, and for a 9-inch drain 1 in 90. To ensure self-cleansing the velocity should not be less than 2·5 feet per second. The maximum discharge takes place when the pipe is running nine-tenths full. The main drain should be bedded in concrete. The house drain is usually disconnected from the sewer by means of a disconnecting or Buchan trap (Fig. 84), which prevents reflux of sewer air and at the same time admits fresh air to the drain.

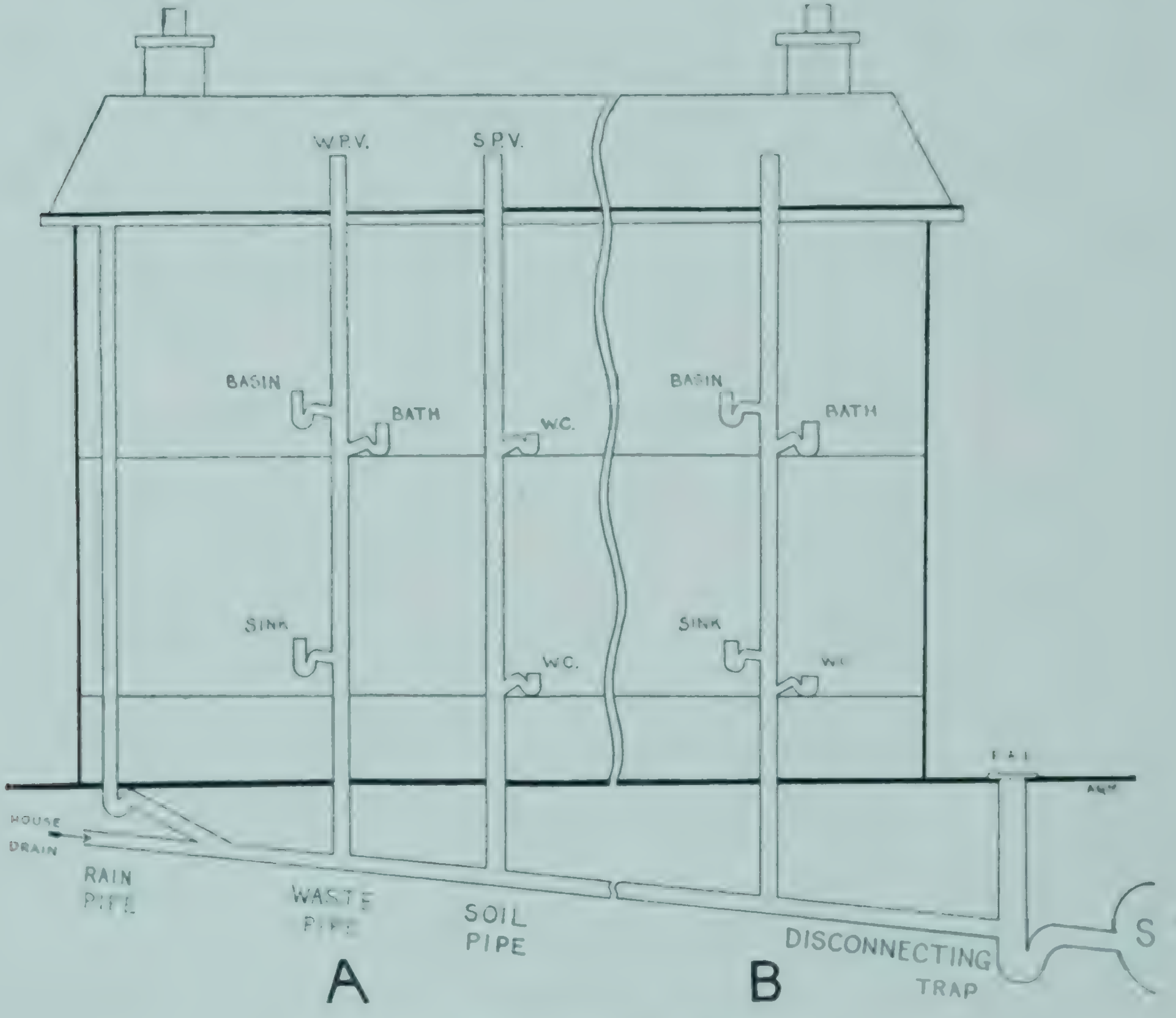

Fig. 84.—House Pipes.

A Two-pipe System. B One-pipe System.
WPV Waste Pipe Ventilator. FAI Fresh Air Inlet.
SPV Soil Pipe Ventilator. S Sewer.

Drain Tests

For new work the best test is the *air* test in which a length of drain is plugged above and air pumped in under pressure. The gauge should stay constant for five minutes. If it falls a leak exists, but its site is difficult to find. A *pull through* test, of the ball type, should be applied to stoneware drains after jointing, to ensure that no cement has worked through a joint and is jutting into the lumen.

For old work, and frequently for new work, the *smoke* test is employed. The smoke of smouldering oily waste is blown from the smoke machine into the fresh air inlet of the Buchan trap till it appears at the tops of the soil and waste pipe ventilating shafts. The test is good for defects in vertical pipes. In the case of underground drains it may fail to show at the surface or, if it shows, may give little clue to its point of origin. A smoke rocket may be used instead of a smoke machine.

Sewers

Sewers may be constructed of glazed fire-clay, stoneware, concrete, reinforced concrete, iron or steel. Glazed fire-clay and stoneware pipes are made circular up to about 24 inches diameter and egg-shaped up to about 24 by 16 inches. Concrete pipes are now available in all shapes and sizes, the larger sizes being reinforced with iron or steel. Where foundations are unstable or the sewage is under pressure, as in the case of an inverted siphon or a tidal outfall sewer, iron pipes or steel tubes are used or reinforced concrete pipes are laid in concrete.

The fall of sewers depends on circumstances. To ensure self-cleansing their minimum velocity of flow should be from 2 to 3 feet per second. Where velocity is low they may be flushed from hydrants through the street grids or by special flushing tanks or flushing gates. An intercepting sewer is a main sewer intercepting the flow of branch sewers. An outfall sewer is one terminating in an outfall. It is usually made circular irrespective of size.

The size or carrying capacity of a sewer necessary in order to obviate flooding is governed by the following factors among others:

Population draining into the system.
Trade waste waters discharged into sewers.
Rainfall. The maximum rainfall expected per hour.
Run-off. The proportion of rainfall reaching the sewer, which may range from 10 per cent. for porous ground up to 90 per cent. for paved surfaces. The actual run-off may be ¼ inch to ¾ inch or more per hour.

Slope. The run-off from a steep street enters the street sewer quickly and the street sewer flowing with high velocity quickly takes it down to the intercepting sewer. An intercepting sewer in such a position needs increased carrying capacity.

Storm Overflows. The use of these will largely depend on the natural facilities available for the disposal of discharged storm water.

For low-lying towns or flat sites where a continuous fall for sewers is not procurable Shone's Ejector will be found of service. It is an air-tight chamber into which the sewage from a low level sewer flows by gravitation. When the chamber is full the sewage lifts a spindle which admits compressed air. This air ejects the sewage in the chamber up an exit pipe into a high level sewer, in which it resumes its onward journey.

Sewers are laid in straight lines with access manways 60 yards or more apart or where direction changes. Ventilation is provided for at the manways, which are vertical shafts leading down to the sewer from the centre of the street or road. Each manway is guarded by an iron cover with ventilating openings. Sometimes a ventilating shaft is carried up above the roofs of the houses. The ventilation of sewers is spontaneously aided by the flow and rise and fall of the sewage.

When a sewer discharges into tidal water it is commonly guarded by a tide- or flap-valve to prevent the discharge of sewage on the flood and permit it on the ebb. The capacity of the terminal portion of the sewer is so designed that when the flap-valve is closed by the rising tide it is not forced open by the pent-up sewage until the ebb sets in. Then the sewage, discharged on the ebb, is carried down stream or out to sea. The best point of outfall for such a sewer is determined from the run of the local currents, ascertained by charting the tracks of marked floats under many conditions of wind and tide.

The air in sewers is moist, more or less free of dust, and in a well-running sewer comparatively inoffensive. Colonel Horrocks found *B. typhosus* in the air of a drain carrying typhoid dejecta, but Winslow's more recent work suggests that, though sewage as it flows is heavily charged with intestinal bacteria, the number of *B. coli* ranging up to 100,000 per millilitre, yet the air of a smooth-running sewer is normally free. The very few bacteria of this type which he recovered from sewer air were strictly localised to points where the sewage was foaming or splashing. It is now generally agreed that the risk of contracting disease such as typhoid fever from sewer air is for practical purposes negligible, but the constant leakage into houses of sewer air from defective drains may from its content of hydrogen sulphide occasion malaise in children.

Sewer-men are however exposed to the risks of their calling. The spirochaetosis from which they occasionally suffer is derived from contact with the sewage itself or the walls of the sewer. Where sewage is decomposing, as at dead ends or points of chokage, H_2S may be liberated in toxic doses, or in lower concentrations may produce conjunctivitis. Coal gas entering sewers from leaking gas mains may cause carbonic oxide poisoning or else may be exploded by naked lights. Waste petrol from garages, benzene or naphtha from trade waste, as well as methane from decomposing sewage, are all liable to form explosive mixtures. A grave hazard of sewer-men is to be overtaken by storm water.

SEPARATE SYSTEM

Rain being excluded from the sewers on the separate system, the total quantity of sewage is less, and the sewers of smaller size, than on the combined system and also the volume and composition of the sewage are more constant. The rain pipes either discharge into surface channels or are led to underground drains cut off from the sewers proper.

CONSERVANCY SYSTEM

On the conservancy system excreta are not disposed of by water carriage but remain for varying periods in the proximity of houses. Privies must be out of doors at least 6 feet from the dwelling and 40 feet from a well or spring. They should be adequately lighted and ventilated, and should have a non-absorbent floor 3 inches or more above ground level. In pail privies the pail should have a content of not more than 2 cubic feet. It should be cleared at least once a week and the contents disposed of in a shallow trench and covered with earth, or burned. Earth privies, fitted with a simple apparatus for the automatic application of earth after use, are available for rural schools. In chemical privies, which may be purchased for domestic or school use, and may be employed also in civil aircraft and long distance motor coaches, the excreta are received and disintegrated in a tank containing caustic soda or other disinfectant in solution. The contents of the tank, which are sterile, may be run into a soak pit. House waste water on the conservancy system may be run into a soak pit or led by an agricultural drain to a sedimentation tank with overflow to a ditch or stream.

Where rural houses, isolated or in series, have a piped water supply, they may be provided with drainage of house waste water *plus* excreta. In such cases the effluents are generally collected in cesspools which are periodically emptied. This is nowadays conveniently done by the 'vacuum gully emptier' which is a closed steel tank of approximately 1,000 gallons capacity mounted on an automobile chassis. The engine is employed to create a partial vacuum in the tank from which a flexible pipe is lowered into the cesspool. When the valve is opened the sewage is sucked up into the tank and later disposed of by land treatment.

CAMP WASTE

The cookhouse waste of camps should be burned in improvised brick incinerators. While awaiting disposal it should be placed in covered pails or tubs. Clean edible waste may be passed over to pig-keepers. Grease should be placed in square soakage-pits of appropriate size, filled with brushwood which acts as a strainer for solids and can afterwards be burned.

The disposal of excreta in permanent encampments should be by water carriage. In temporary camps latrines may be constructed on the long or short trench plan. In the former the trench is 20 feet long, 2 feet deep and 1 foot broad. This suffices for 100 persons. The short trench, 3 feet in length, is otherwise identical with the long type. Four short trenches are required for every 100 persons. Seating arrangements take the form of a pole supported on forked uprights and provided with a back rest. Where possible the trenches should be roofed by sheets of corrugated iron. Grass sods, lifted at the time of digging, should be stacked for replacement when the trenches are filled in. Excreta should be covered each day with dry earth, and bleaching powder should periodically be scattered on top. Flies should be repressed. The 'bore' latrine, which is a shaft 16 inches in diameter and up to 18 feet deep, surmounted by a seat and superstructure, has lately been employed with success. Excreta dissolve in the subsoil water and one bore will serve for long periods without attention. Urinals may either take the form of soakage-pit trenches or consist of metal buckets which can be emptied into pits. Hessian screens surrounding latrines or urinals should be changed from time to time. They should not in any case be too near to the trenches which they enclose.

DIRECT DISPOSAL

The disposal of sewage in its crude state direct into the sea or tidal water is carried on by many towns in Britain. The practice is legal except for tidal waters determined by the Central Health Authority to be streams in terms of the Rivers Pollution Prevention Act, 1876. The discharge of sewage into Belfast Lough led to an overgrowth of the green sea-lettuce *Ulva latissima*, which created nuisance as it decayed.

Crude town sewage, if intended for direct disposal into the sea, should be led by intercepting sewers to a tank sewer or retaining tank. From this it should be released on the ebb so as to be carried offshore by the currents or, in an estuary, towards open water. The outfall sewer should discharge under low-water mark. Screening of the sewage as it leaves the retaining tank will promote amenity on the sea front.

SEWAGE PURIFICATION

As it is illegal, under the Rivers Pollution Prevention Acts, to discharge untreated sewage into a stream or river the sewage of most towns requires purification before its final disposal. Physically, as stated by the Royal Commission on Sewage Disposal, sewage is 'a mixture of saline matter in solution and nitrogenous and carbonaceous organic matter in solution and suspension together with a certain amount of grit and mineral matter.' Its bacterial content is high. The total bacterial count in 1 millilitre ranges from 1 to 10 million, and the number of *B. coli* in 1 millilitre has been computed at 100,000. The standard of purity should be such that a river or stream receiving the sewage will not show signs of pollution or have its amenity destroyed. A standard for effluents is therefore requisite.

STANDARD FOR EFFLUENTS

The object in view in the purification of sewage for disposal otherwise than by direct discharge is to take out the suspended matter which it contains and to oxidise the residue of dissolved organic matter. Effective treatment, in addition, lowers the bacterial content. The degree of purification required is more dependent on the destination of the final effluent than on the initial composition of the sewage.

The Royal Commission on Sewage Disposal in their Eighth Report suggested as the normal standard for effluents—

> That an effluent should not contain more than 3 parts of suspended matter per 100,000, and
>
> That including its suspended matters it should not take up more than 2 parts of dissolved oxygen per 100,000 in 5 days at 65° F. (18.3° C.).

A stream of average purity, taking up 0·2 part of dissolved oxygen in five days, if more than eight times the volume of such an effluent will, after receiving it, ordinarily be free from signs of pollution.

The formula of compliance is

$$\frac{x+yz}{3+1} = 0{\cdot}4$$

where x and y are the parts of dissolved oxygen per 100,000 taken up in five days at 65° F. by the effluent and the stream before receiving the effluent respectively, 0·4 is the corresponding figure for the stream after receiving the effluent and z is the proportion of the stream to the effluent.

The normal standard should be applied in cases where a complete system of purification is called for. If the stream dilutes the effluent less than eight times, the case must be considered on its merits, if any. If the dilution is 150 times or over, the dissolved oxygen test may be dispensed with. At dilutions of 150 to 300, suspended solids may rise to a limit of 6 parts per 100,000, for which chemical precipitation would suffice. At dilutions of 300 to 500 the limit may be 15 parts, for which tank treatment, if properly worked, would suffice. At dilutions over 500, sewage may be discharged untreated, though screening or grit settlement are recommended in the interests of amenity.

The current processes of sewage purification may be classed as (1) Preliminary and (2) Completing. *Preliminary Processes* remove the gross and reduce the fine suspended solids. *Completing Processes* deal with the residual suspended solids and oxidise what remains. As a rule treatment works discharging into streams are expected to aim at complete purification, including both preliminary and completing processes. While the bacterial content of sewage is substantially reduced by efficient purification treatment, no attempt is made at sterility so that a river which has received even the best effluent still ranks as sewage-polluted and therefore unfit to be drunk without previous treatment.

PRELIMINARY PROCESSES

Screening. Screens hold back gross floating solids. Fixed bar screens, leaning away from the flow of sewage, with a ½-inch interval between the bars, are usual in this country. Fine wire mesh may also be employed in the form of an inclined moving endless band which lifts the solid material clear of the sewage and tips it over into a trough. Wire mesh screening was highly specialised in Germany, where it served in some cases as a terminal process. Screening on an average removes 10 per cent. of the matter in suspension.

Grit Settlement. The screened sewage passes into a grit chamber or detritus tank, in which its heavy particles settle. The chamber, which may conveniently be in duplicate, is generally constructed of cement-faced concrete. It is cleared, according to its size, by hand, chain-bucket or sludge-valve with sludge discharge pipe. If the sewage is regulated to flow through the chamber at the rate of ½ to 1 foot per second its deposit will be mainly mineral. A grit settlement tank may hold twenty minutes flow.

Continuous Flow Sedimentation. The continuous flow sedimentation tank is an open tank of material similar to that of the grit chamber. For an average sewage the tankage in use should equal eight hours dry weather flow, that is to say, allow eight hours settlement. Tanks should be provided in duplicate. A sedimentation tank is usually of rectangular shape, three or four times as long as broad. It has a mean depth of 6 feet, and is deepest at its inlet end from which its floor should slope evenly at 1 in 20 up towards its outlet. The screened and grit-settled sewage enters deep on the proximal side and emerges as tank liquor, after sedimentation, over a broad weir. The exit is guarded by a scum-board to arrest floating substances. Baffle boards are not required. The entering sewage is richest in suspended matter and flows more slowly than near the outlet. Thus the sludge, as the deposit of sediment is called, is thickest at the inlet end. Here the sludge-wall is placed and the gathered sludge is removed from it every few days by means of a sludge valve or chain pump or by hand, according to size and circumstance. A convenient and speedy method of sludging is essential to good work. At longer intervals the whole tank may be emptied and all deposit pushed by squeegee or otherwise down the sloping floor into the sludge-well for removal. The *Imhoff* type is a specialised form of tank in which the sewage flows in an upper channel, throwing its suspended matter down through a special slot into a lower compartment. Gases and sludge rising from the floor of the tank as decomposition proceeds are excluded from the upper channel by means of an interposed baffle. The capacity of the upper channel is from one to three hours flow. Imhoff tanks have had a vogue in Germany and North America. In the *Dortmund* tank there is a central downcast cylinder with distributing arms. A 50 per cent. reduction of suspended solids is readily affected by continuous flow sedimentation. A settlement period of more than eight hours may give a higher reduction figure, but not high enough to balance the cost of the additional tankage and the risk of the sewage becoming septic.

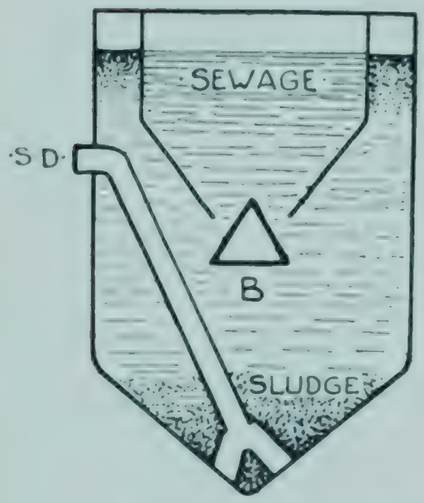

Fig. 85.—Imhoff Tank.

B, Baffle.
S.D., Sludge Discharge.

Quiescent Sedimentation. On the quiescent plan the tank is filled up, left full for 2 to 4 hours to allow deposit, and then drawn off. This fill-and-draw method produces more sludge than continuous flow, but requires more supervision and involves more loss of head.

Precipitation. If a sewage is strong or contains trade waste, chemical precipitation gives good results. Lime with or without 'aluminoferric' or 'ferrozone' is commonly employed. The amount used varies from 5 to 15 grains per gallon. The tank liquor is well clarified, but the deposited sludge may exceed in amount the original suspended matter. The dissolved impurities are little affected. 'Aluminoferric,' forming colloidal alumina, may take out 5 per cent.

COMPLETING PROCESSES

The biological completing processes for the purification of sewage exemplify the nitrogen cycle which breaks the dead protein molecule down to simple substances on which life is built up anew.

When animal protein is deposited in soil its disintegration begins almost at once. It is accomplished partly by enzymes and partly by bacteria, some of which are soil-specific. Amongst the earliest products of decomposition are organic amines, or ptomaines, such as putrescine and cadaverine, which in turn are attacked by bacteria and yield first methylamines and then ammonia. Much of the ammonia so produced unites with soil bases to form ammonium carbonate, which is soon converted by the bacterium *Nitrosomonas* to nitrous acid. This unstable compound readily combines with potassium and sodium to yield unstable nitrites. These are rapidly oxidised to nitrates through the agency of *Nitrobacter* organisms, and pass into solution in the ground water, whence they are absorbed by plant roots. With the aid of the symbiotic *Rhizobium radicicola*, which inhabits their root nodules, the Leguminosae can also ultilise atmospheric nitrogen. In waterlogged or otherwise unhealthy soils, coliform bacteria may reduce nitrates to nitrites, and *B. denitrificans* may liberate their nitrogen in gaseous form. There are similar cycles for carbon, sulphur, phosphorus and other elements.

The nitrogen cycle for excreta is similar to that for animal protein as described. Faeces are decomposed by bacteria to yield indol and skatol, which are finally converted to ammonia by soil organisms. Urine liberates urea which is changed by *B. ureae* to ammonium carbonate. In the breakdown therefore of both urine and faeces the terminal product is ammonia, just as in the formal nitrogen cycle. Sewage, which contains urine and faeces in various stages of decomposition, is rich in ammonia. In water analysis an ammonia figure above normal may thus indicate sewage pollution.

Nitrites, being unstable, do not survive long or travel far in the ground water. In water analysis their presence even in traces raises the question of recent sewage pollution. Nitrates being more stable may remain unchanged in the ground water for long periods. In water analysis the occurrence of nitrates may indicate sewage pollution, not necessarily recent. In the biological treatment of sewage, one purpose of which is to mineralise the ammonia which crude sewage contains, the absence of nitrates from an effluent means that this purpose is not being achieved.

The biological completing processes which function as stated above are (1) Land Treatment in its three varieties, Subirrigation, Intermittent Downward Filtration and Broad Irrigation, (2) Filtration and (3) Bio-aeration. With these may be associated (4) Chlorination, which is bactericidal.

Land Treatment. Sewage brought into contact with land undergoes proteolytic and other disintegration. Through the action of the natural soil bacteria, aided by those contained in the sewage, the organic derivatives in the sewage are broken down into simpler compounds which are subsequently oxidised. Important end-products are the nitrates formed by the oxidation of excretal and proteolytic ammonia.

Subirrigation. The roughly sedimented sewage is introduced, in 4-inch open-jointed agricultural drains laid 3 feet apart, 1 foot below the surface of a plot of open sandy soil. The open joints should be guarded above and below by half-pipes, and the line of drain at its distal end should turn up to open free in the air. An automatic siphon discharge is desirable to distribute the sewage along the drains. In general terms one acre is enough for 250 people. The method is best on the small scale for a country house or village.

Intermittent Downward Filtration, according to the Royal Commission of 1882 on Metropolitan Sewage Discharge, is 'the concentration of sewage at short intervals on an area of specially chosen porous ground, as small as will absorb and cleanse it, not excluding vegetation, but making the produce of secondary importance.' The sewage, either crude or screened and roughly sedimented, is distributed over loam or sand beds containing lime. Clay and peat are inadmissible, since bases are required to combine with nitrous and nitric acids: otherwise nitrification would cease. Intermittency too is necessary to prevent water-logging and de-aeration of the soil, which would likewise stop nitrification. Six hours flow followed by eighteen hours rest will usually be satisfactory. One acre of land suffices for about 1000 people, varying with local conditions. Four-inch agricultural tile pipes should be laid 4 or 5 feet below the surface to act as under-drains and effluent channels. The ridge and furrow arrangement is usual, with vegetables growing on the ridges. Intermittent Downward Filtration, in some of its forms, closely resembles Broad Irrigation.

Broad Irrigation was defined by the Royal Commission on Metropolitan Sewage Discharge as 'the distribution of sewage over a large surface of ordinary agricultural ground, having in view a maximum growth of vegetation (consistently with due purification) for the amount of sewage supplied.' This is the method of the sewage farm. The sewage, usually screened, grit-settled and partially sedimented, is led to the site if possible by gravitation, and is distributed, by means of open concrete main carriers giving off subsidiary open half-pipe carriers, over land that may be of any composition but peat or stiff clay. It should be kept in view that on chalk formations there is a risk of the sewage being swallowed by fissures. The ground, of which one acre is usually allowed per 100 of population, requires periods of rest. It is laid out either on the ridge and furrow system with 30 to 60 feet from ridge to ridge or, if sloping, on the catchwater plan with a series of parallel trenches. The tributary under-drains of 4-inch agricultural tile are 4 or 5 feet below the surface. The master drains into which they discharge are socketed stoneware pipes with closed joints. Favourite crops are rye-grass and mangolds, or Brussels sprouts, celery, carrots and beet. A dairy or fat stock farm may be added. Owing to evaporation from the soil and transpiration from the luxuriantly growing produce, the effluent in dry weather in some cases may cease to flow entirely. For the excess of sewage in wet weather special filtering areas may be required. The purification process in broad irrigation takes place partly on the surface, partly in the soil. When the land is overdosed the surface film thickens, turns greyish-black and offers resistance to the sewage, which ponds instead of percolating. The land is then said to be 'sewage-sick.' The cure for this sickness is rest, followed by scarification or ploughing. Sickness also occurs through exhaustion of the bases referred to under Intermittent Downward Filtration. For this type the cure is rest and treatment with lime. The sewage farm in general is an efficient purifier, but is usually outclassed now for large scale undertakings by the high cost of land near populous places.

Filtration. This method is modelled on the purification which occurs in the soil. The oxidising action takes place in trickling, sprinkling, streaming or percolating filters, as they are variously called, which are built of coarse clinker or other hard material, roughly graded from below upwards. They are either circular or rectangular and are under-drained over a water-tight concrete floor. They are 5 or 6 feet deep and may or may not have a brick retaining wall. They may be used in series. The screened, grit-settled and fully sedimented tank liquor is delivered over the filter beds by either fixed or travelling distributors. The fixed distributors include sprinkler nozzles, which need several feet of head. Among travelling appliances are the rotary Candy distributor, its arms automatically impelled by escaping jets of sewage, and the Fiddian distributor (Fig. 86), an overshot waterwheel, also automatically sewage driven, which can be adapted to both circular and rectangular beds. The clinker becomes covered with a gelatinous film which is peopled by proteolytic and nitrifying bacteria. The film, when the liquor gushes over it, attaches the fine suspended particles and takes out and holds the dissolved protein derivatives. When the flow has ceased, the film absorbs oxygen from the air, which with bacterial aid oxidises the retained organic matter to stable compounds of carbon,

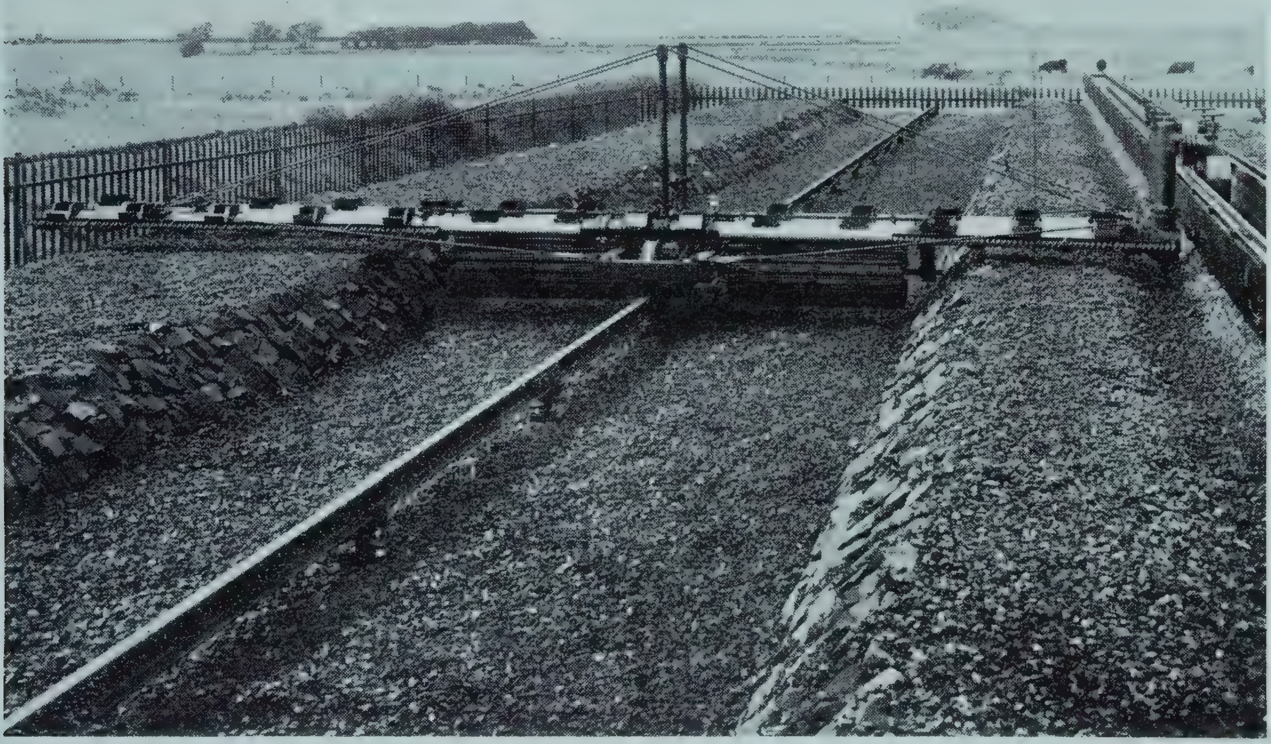

Fig. 86.—Travelling Distributor, Fiddian type.
The sewage is distributed by the moving overshot water-wheel activated by siphonage from the sewage channel on the right.

sulphur and nitrogen. Carbon dioxide and nitrogen are free in the air of the filter, and carbonates, sulphates and nitrates are found in the effluent. If a filter effluent contains no nitrates the filter is doing no work.

To enable the film to oxygenate itself, access of air is necessary, and also an alternation of flow and rest which the travelling distributors obviously provide. An overdosed filter clogs and blackens and the tank liquor ponds on its surface. The blackness is due to the formation of hydrogen sulphide H_2S which combines with traces of the ubiquitous iron to form iron sulphide. Overdosing may mean either excessive delivery of liquor to the filter or inadequate sedimentation before delivery. Foul odours round filters are usually caused by the distribution of sewage containing certain trade wastes or of putrid liquor from ill-sludged tanks. The most malodorous gases are the sulphur compounds. They are least obnoxious with the type of distributor which discharges close to the surface of the filter.

The substance known as 'humus,' which consists of organic by-products, remains in the filters for a time, but is flushed out periodically, especially in spring. It is flaky and ponderable and readily settles. Humus tanks holding about two hours flow are provided to arrest it. The fauna of percolating filters includes the insects *Achorutes purpurescens* and *Achorutes viaticus* which feed on organic matter and thus aid the passage of humus. The tiny flies *Psychoda sexpunctata* and *Psychoda phalaenoides* are also frequenters of filters, breeding in the dry chinks of their exposed surfaces. They are not blood-suckers, but when numerous are annoying. Carbon bisulphide is employed for their repression.

A percolating filter can deal with 75 to 250 gallons of tank liquor per cube yard per day. The sequence of screen, grit chamber, sedimentation tank, percolating filters and humus tank should, with adequate care, work well up to the standard for effluents suggested by the Royal Commission on Sewage Disposal. The bacterial efficiency of the combination is high, and a percentage reduction of 90 to 95 per cent. has been claimed, but even this improvement, on an initial count of 100,000 *B. coli* per ml. leaves the effluent thronged with excretal bacteria.

Bio-aeration is modelled on the self-purification of turbulent rivers. Originating from laboratory experiments at the Davyhulme Sewage Works of Manchester Corporation the bio-aeration or activated sludge process has developed rapidly and become world wide. Activated sludge is a product formed by the application of well defined principles to screened and detritus-free sewage. If such sewage is continuously agitated under aerobic conditions particles of light flocculent matter will be observed to separate out. These flocculent particles, which form the nuclei of activated sludge, gradually develop biological properties in virtue of which they are able to clarify and purify the sewage.

Activated sludge has no associations with the solid matter of crude sewage or the sludge of the ordinary sedimentation tank: it bears however a close analogy to the active gelatinous film which covers the clinker or other solid material of percolating filters. Both the bio-aeration process and the filters supply bacterial and non-bacterial forms of life, including protozoa such as *Vorticella,* with nutrient media for their growth and development: both work under aerobic conditions, effect parallel cycles of bio-chemical change, and depend for their efficiency on the closeness, frequency and duration of interfacial contact between their active media and the sewage under treatment. They differ however in the mechancial means by which they respectively solve the problem of contact. In the Manchester system the form of energy employed to agitate, circulate and aerate the sewage and activated sludge is compressed air. In the Sheffield system the agitation and aeration are effected entirely by vertical paddle wheels, alternate paddles rotating in opposite directions. The Simplex system shakes and aerates the sewage in vertical Dortmund tanks by means of whirling cones which carry horizontal blades. In each case some activated sludge is recovered, held and pumped back to the starting point where it mingles with the entering screened, grit-settled and tank-sedimented sewage.

In the bio-aeration process differences in the strength and character of the sewage are reflected in the duration of its detention period in the aeration or agitation tanks. As this period of detention determines the capacity of the tanks necessary to treat a definite volume of sewage and also the power required, it follows that the capital expenditure and running costs of all three systems vary with the strength and character of the sewage treated. A detention period of 6 hours suffices completely to purify a weak domestic sewage, whereas a strong trade waste sewage may require from 8 to 16 hours.

In practice the ratio between the volume of sewage under treatment and the volume of activated sludge in operation varies. Experimental work and experience have proved that the employment of the large volumes of sludge originally thought necessary is uneconomic and fulfils no useful function. Present-day practice tends towards a reduction in the volume of activated sludge, and in most plants the percentage by volume measured after one hour's settlement will be found to range from 10 to 15.

Spent sludge is removed from time to time and may be treated by heat and agitation in a digester, with the production of methane and other inflammable gases which can be used for heating or illumination and also to drive the machinery of the plant.

Chlorination may be applied to a sewage effluent in order to reduce its bacterial content before discharge into a river. It is useful where a waterworks intake adjoins a sewage works outfall. With an effluent which conforms to the Royal Commission's standard, referred to above, a dose of 5 parts per million normally suffices. The bacterial counts may be brought down to a few hundred per ml., and *B. coli* so far reduced as to be absent from 10 ml. The chlorination of sewage with a view to the control of septic odours is more difficult, since the requisite dose of chlorine may exceed 20 parts per million. As sewage contains ammonia the addition of chlorine forms chloramine, more bactericidal than chlorine but slower in action. It may therefore be necessary in some cases to hold back the chlorinated effluent for a time before permitting it to join the destined river.

STORM WATER

Storm water which would flood the sewerage system is diverted by means of storm overflows, which are described as either local or main.

Local Storm Overflows relieve the branch sewers. They are so constructed as to come into operation at several times the maximum dry weather flow. A good type is that regulated by a dipstone which diverts storm water into the outlet channel. The Royal Commission on Sewage Disposal thought that local storm overflows should be sparingly used.

Main Storm Overflows are placed on main outfall sewers to control the delivery of storm sewage to the purification works. The Royal Commission on Sewage Disposal recommended that up to three times the dry weather flow of sewage should be admitted to the works for treatment as usual. Over three and up to six times the dry weather flow should be run into stand-by tanks, holding one-quarter of the dry weather flow, after sedimentation in which it might be discharged from the works without further treatment. Over six times the dry weather flow may be excluded from the works and discharged to a stream untreated.

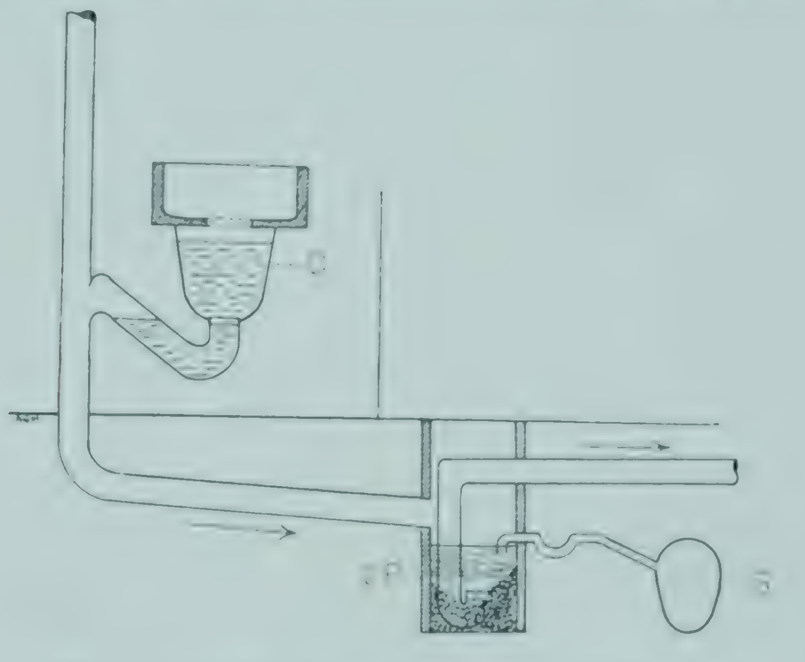

Fig. 87.—Garchey System: Collection.
C, Container. CP, Collecting Pit. S, Sewer.

SEWAGE DISPOSAL

Sewage which has been purified by a combination of the methods above outlined is fit for final disposal by discharge into a stream or river of appropriate size. It is legal for coast towns to discharge their sewage untreated into the sea or tidal water, but screening at least should be practised in order to preserve the amenity of fore shores. The run of the currents should be studied, the point of outfall chosen to suit, and discharge arranged to take place on the ebbtide.

The sludge of sewage has a manurial value, though it contains up to 90 per cent. of water. In disposal methods which include a drying process the end-product may under favourable conditions be saleable, but usually at a non-remunerative figure.

In *lagooning* the sludge is run into shallow lagoons, in which it slowly and malodorously dries. When spadeable, it is ready for use as manure. *Flooding* on land resembles lagooning. In *shallow burial* the sludge is passed into shallow trenches and covered lightly with earth. This method is good if enough land is available. Deep burial is useless. In *filter press* treatment the sludge, dosed with one per cent. of lime and compressed by a forcing ram or other mechanism, has its water content reduced to 50 or 60 per cent. In places where the pressed sludge is unsaleable it may be given away as fertiliser, or burned in a refuse destructor, or filled into hollows, or dumped at sea, or made into briquettes. *By-products recovery* has been carried out at Bradford, where the sludge is rich in grease from wool washings. There is a market for both the grease and the pressed cake, the latter of which contains only 25 per cent. of water. At Oldham attempts have been made to extract the fatty acids of soap from sludge. In *centrifugalising*, as employed abroad, the water in sludge is reduced to between 50 and 70 per cent. *Submersion at sea*, where practicable, is cheap and effective. London sludge is conveyed in sludge steamers to the Black Deep of the Thames estuary. Part of the Glasgow sludge is sunk in deep water in the Firth of Clyde, and part of the Manchester sludge is taken on steamers by way of the ship canal to the Irish Sea. The process of *heat-digestion* has already been referred to in connection with activated sludge.

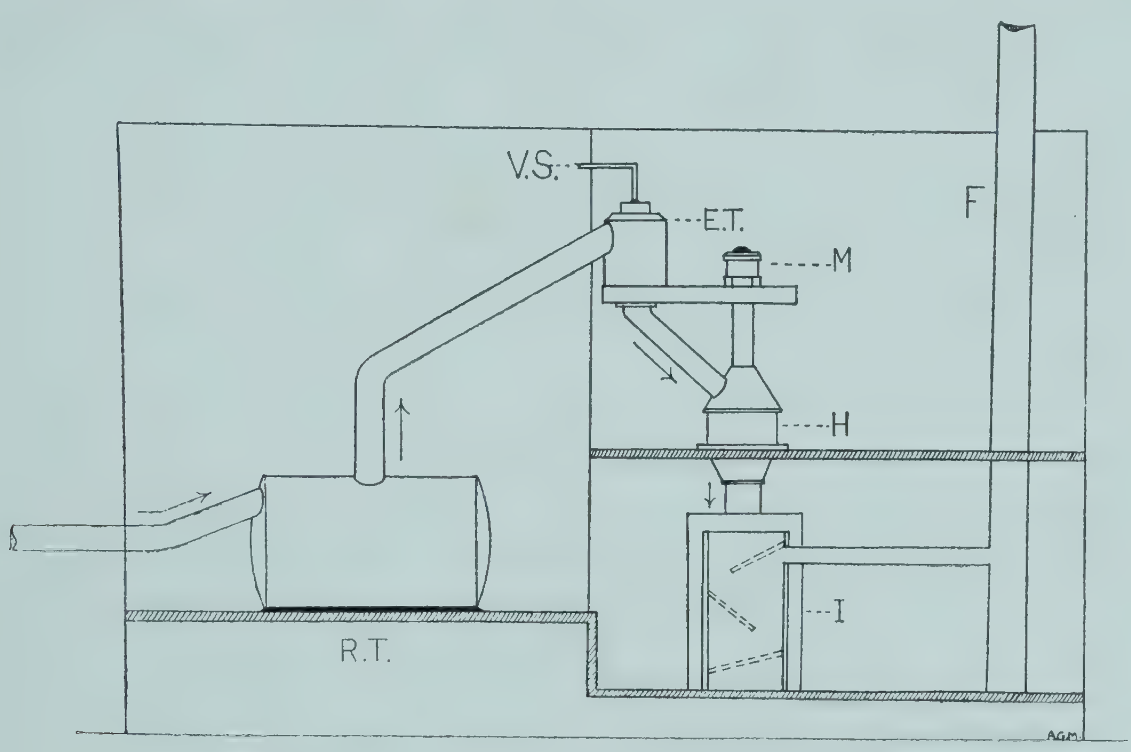

Fig. 88.—Garchey System: Disposal.

R, Receiving Tank. E.T., Equalising Tank. H, Hydro-Extractor. M, Motor. V.S., Vacuum System. I, Incinerator. F, Flue.

GARCHEY SYSTEM

The Garchey System for the disposal of domestic refuse begins with a white glazed fireclay sink, usually sited in the scullery or kitchenette. The large outlet from the sink, with movable grid, opens into the subjoined Container 'C' (Fig. 87). The grid, when in position, closes the outlet, and the sink can then function as an ordinary wash-up sink, the waste water being run away into the container. With the grid off, the outlet is open, so that the domestic refuse, made up of garbage, tin cans, ashes and other constituents, can be dropped direct into the container to be immersed in the waste water there.

The exit from the container is guarded by a plug which can, when necessary, be lifted clear by means of a handle provided. When the plug is lifted, all the water and refuse in the container are flushed by gravity along a chute pipe to the Collecting Pit 'CP.'

After the surplus water in the collecting pit has been run off to a convenient sewer 'S,' the solid refuse left behind in the pit, together with the water enclosing it, is forcibly sucked away, under strong negative air pressure to the Receiving Tank 'RT' (Fig. 88), at the Disposal Station.

From the receiving tank the wet refuse is lifted, either by vacuum or compressed air, to the Equalising Tank 'ET,' from which, still wet, it is conveyed down by gravity to the Hydro-extractor 'H' for centrifugal drying. Finally, when sufficiently dry, it is permitted to fall into the Incinerator 'I.' There it is burned to ashes.

'F' is the flue of the incinerator. 'M' is the motor of the hydro-extractor. 'V.S.' shows the position of the Vacuum System.

RIVERS POLLUTION

Statutes designed to improve and maintain the purity of rivers and streams in Britain, beginning with the Rivers Pollution Prevention Act of 1876, aimed in the first instance at the recovery of potability. Soon, however, it became manifest that such a standard would be attainable only in quite exceptional cases, and subsequent legislation turned rather to the question of amenity. The Royal Commission on Sewage Disposal beginning in 1898, carried on for seventeen years an exhaustive inquiry, both practical and scientific, into the subject of their remit. Their findings are recognised as authoritative, and have passed into the current stock of knowledge. They submitted, in all, ten Reports. The Eighth, published in 1912, fixed a standard for sewage effluents proposed to be admitted to rivers. The Final Report, which appeared in 1915, summarised the findings of the Commission. It pointed out that land treatment was not infallible. Effluents from unsuitable lands were very impure. In any event land near large cities could not be obtained at reasonable charges. Artificial methods of purification must therefore be employed and their effluents admitted to rivers. Further, bacteriological findings, which had now become available, showed that effluents even from plants working in a satisfactory manner were thronged with bacteria many of which were pathogenic. Such effluents could not be effectively sterilised. Even if they could be, there were other sources of pollution. The Commission therefore abandoned the policy of attempting to recover potability: and in their normal tests for effluents simply aimed at producing a river which would 'ordinarily be free from signs of pollution.' That is to say, they acquiesced in an amenity standard.

The existing law on Rivers Pollution is contained in the Salmon and Freshwater Fisheries Act, 1923, in the Public Health Act, 1936, and in the Public Health (Drainage of Trade Premises) Act, 1937.

Under the Public Health Act, 1936, it is an offence to discharge into a stream foul water until such water has been so treated as not to affect prejudicially the water in the stream. It is likewise an offence under the Act to throw into a stream or river any ashes, stones or rubbish likely to cause annoyance.

Equivalent provisions for Scotland are contained in the Salmon Fisheries (Scotland) Act, 1862, the Burgh Police (Scotland) Act, 1892, and the Public Health (Scotland) Act, 1897.

Riverine Life

A blameless stream in the view of the Royal Commission is one which, having received the normal effluent under prescribed conditions, does not take up more than 0·4 part of dissolved oxygen per 100,000 in five days at 65° F. If the organic content exceeds this value there is risk of nuisance arising. Sewage fungi may appear in the water attached to twigs and weeds, first *Leptomitus lacteus,* then *Sphaerotilus natans* and *Beggiatoa alba,* the last of which splits hydrogen sulphide. As oxygen disappears putrefactive bacteria flourish liberating malodorous gases. Then gradually as the river flows on purification begins. The foul stream is diluted with fresh incoming water. Green weed reappears showing the return of oxygen, and granted sufficient length of flow amenity may be restored. Placid rivers take up atmospheric oxygen slowly: turbulent rivers absorb it rapidly as successive water surfaces are exposed to the air.

Fish are sensitive to lack of oxygen and die of asphyxia in streams sufficiently deoxygenated by sewage. Some trade effluents inflame the gills of fish with grit: others are directly toxic to them. Enactments for the protection of fisheries conduce appreciably to maintain the good condition of rivers. The Salmon and Freshwater Fisheries Act, 1923, which applies to England and Wales, prohibits the discharge into waters containing fish, both salmon and others, of any liquid or solid matter to such an extent as to cause the waters to be poisonous or injurious not only to fish but to their spawning grounds, spawn or food. A sub-committee of the Standing Committee on Rivers Pollution appointed by the Minister of Agriculture and Fisheries have suggested as a guide to the quality of an effluent that, should no physiological abnormality be observed in yearling perch, roach or trout during treatment extending over one to three hours, the effluent will probably not be harmful to the inhabitants of a stream.

Self-Purification

Where the charge of sewage admitted to a river is slight or moderate in amount no question of oxygen depletion may arise and self-purification may begin at once. The organic matter is attacked by aerobic bacteria, infusoria, entomostraca and fish. Direct oxidation also occurs, photosynthesis adding its quota of oxygen. Dilution plays an important part and sedimentation helps. The river may remain unimpaired to view by the pollution mingled with its waters, or if impaired at first may quickly clear as it flows and recapture its former beauty, conforming completely to the amenity standard of the Royal Commission, but it is not on that account necessarily purged of the pathogenic bacteria introduced by the sewage. Sunlight and the antibiosis of the aquatic organisms wear down their number, but considerable time and length of flow are required for their complete elimination, and only after their elimination is complete can the river be fit to drink unpurified. Rivers in Britain which receive substantial influxes of sewage must be held suspect for water supply purposes at all points downstream.

Limit of Safe Loading

A town proposing to drink such a river has the duty of self-protection. Experience shows that it is in general easier to safeguard a river supply by water purification at the water intake than to sterilise the contaminating charges of sewage at their numerous outfalls. A practical question therefore arises as to what is the treatable limit, that is to say, how bad must a river be, judged by bacterial or other tests, before it is classed as one which cannot be made fit to drink by current large-scale methods. This point was taken up by the International Joint Commission on the Pollution of Boundary Waters appointed under the treaty of 1909 between the United States and Great Britain to inquire into the pollution of the Great Lakes and other waterways between Canada and the United States, and make recommendations. In 1918 the Commission expressed the view that communities discharging sewage into rivers ought to purify it to such an extent that the resulting average cross-sectional pollution in each river would not exceed the limit of safe loading for a water purification plant. A mean annual cross-sectional average of *B. coli* not exceeding 500 per 100 ml. would comply with this condition. More recently the United States Public Health Service, founding on experience of the Ohio River, reported the following limiting figures: for waters to be treated by filtration without chlorination 60 *B. coli* per 100 ml.: for waters to be treated by methods including chlorination 5,000 *B. coli* per 100 ml.: and for waters to be treated by highly elaborated methods 10,000 *B. coli* per 100 ml.

Admission of Trade Wastes

Under the Public Health (Drainage of Trade Premises) Act, 1937, which extends the trade waste provisions of the Public Health Act, 1936, occupiers of trade premises may with the consent of the local authority discharge trade effluents into sewers. The nature of the effluent, its quantity and its rate of flow must be notified to the local authority who may impose conditions as to the manner and place of discharge. Model Byelaws fix a maximum permissible temperature for the effluent of 110° F., and suggest a pH value between 7 and 10.

Trade wastes which can largely be purified by sedimentation, with or without precipitation, include the effluents from coal washing plant, china clay works, stone quarries, wood pulp paper mills, shale oil distilleries, tanneries and dairies. The wastes from cotton dyeing, bleaching, esparto and rag paper mills and wool scouring may require chemical treatment. Gas works effluents and creamery waste need chemical or biological treatment.

RESULTS

In England and Scotland generally it may be said that on the whole the treatment plant provided from year to year has been keeping pace with the rising volume of domestic and industrial sewage. As the quantity of waste fluid for disposal continues to enlarge, the burden on the rivers will grow heavier and it may become necessary to envisage the complex question of prescribing legal standards. A general amenity standard such as that suggested by the Royal Commission on Sewage Disposal, yielding rivers which will 'ordinarily be free from signs of pollution' would, if applied with due regard to the varying circumstances of districts, probably meet the requirements of riparian tenants, manufacturers who are users of water, stock owners and others. This standard however takes no account of bacterial content, and it would not necessarily—though it often might—safeguard rivers for water supply purposes to such an extent as to render them suitable for drinking after purification.

PROSPECTS

The use of water by British communities has increased, and will go on increasing if it is to satisfy the growing requirements of time and place. There will be, for example, a new demand for water supply for the houses waiting to be built on devastated sites or elsewhere. Also, before too long, the promoters of the New Towns, whether free or satellite, will be out on the quest for new water to constitute the municipal supplies. From what fountainheads may these new waters flow?

For Scotland there would be help from the hills. The most populous areas as now located are not too remote from sources in copiously watered uplands. In parts of England supplies from deep wells or local uplands, though pure, may be found incapable of expansion. Some communities by combination may be able to bring upland water from greater distances than hitherto. Others again may turn for aid to the adjacent river. Rivers, if not over-polluted, will with ordinary filtration and chlorination provide safe and constant supplies of drinking water. For rivers employed or proposed to be employed as sources of potable water there should, in addition to the amenity standard, be a bacterial limit of safe loading for water purification plant. Trade wastes will require to be considered on their merits, and those incapable of adequate purification excluded from rivers which are utilised for water supply purposes.

XV.

HOUSING

Open soils such as sand and gravel, which readily transmit the rainfall, afford good sites for houses. Clay soils, which hold the water, are damp and cold. Alluvial land may be water-logged. The dampness of certain sites may be reduced by subsoil drainage with open-jointed field drains. While most agricultural land is good to build on, ground formed by tipping refuse is quite the reverse. Houses on slight elevations are better placed than those in dips or valleys, being drier on account of the added height, and also cooler in summer and warmer in winter.

ASPECT

It is best for a house in Britain to face a little east of south. A frontage due south secures most sunshine, but in the south of England may be too hot in summer. The northerly aspect is the most sunless: it is suitable for kitchens and larders. A house facing westerly or south-westerly meets the force of the prevailing winds. In small houses the window of the living room should look towards the south so as to catch direct sunlight. In the case of a road running east-and-west this can be arranged easily, though the houses on the south side of the road will have their living rooms to the back. In the case of a road running north-and-south, joined houses parallel to the road cannot face south. In planning areas such roads should as far as possible be left free of dwelling houses.

SURROUNDINGS

Country houses exposed to the full force of winds may receive excess of air and, if the winds are wet, may be damp as well. In some cases protection may be afforded by the rise of a hill or a not too adjacent belt of trees.

Houses in towns are more apt to suffer from air deprivation, and also loss of light. Space is therefore sought to be provided by fixing a minimum width for carriage ways and also a minimum amount of space round houses back and front. The London Building Act of 1894 prohibited the raising of houses in certain streets to a height greater than the width of the street, and in other streets to a height greater than 80 feet unless with the consent of the County Council.

Open space round houses may be secured also by preventing the agglomeration of houses on building estates. Time was when for self-contained houses 12 houses per acre was the approved figure: for two-storey flatted property 16 houses per acre: and for three-storey flatted property 24 houses per acre.

Nowadays in modern practice the tendency is to regulate housing density on the basis of number of persons rather than in terms of houses per acre. The following standards have been suggested by the Ministries of Health and Works:

	Persons per acre, residential density
Open Development	30-40
Outer Ring (Town)	50-60
Inner Ring (Town)	75
Central Areas (Town)	100
Central Areas (Large Towns) ...	120

With a view to the amenity of the immediate surroundings, access ways to houses from the street or road, and any courtyards at the back or sides of houses, should be paved with concrete, stone slabs or equivalent material.

HOUSE CONSTRUCTION

The external walls of a house should be constructed of good brick, stone or other hard and incombustible material, properly bonded and solidly put together with good mortar, cement or concrete.

A standard brick measures 9 by 4½ by 2¼ to 3 inches. It should be made of well-burnt clay. Sandstone and limestone are the principal building stones in Britain. Reinforced concrete or concrete blocks are used also. Substantial frame houses may be constructed of timber on brick foundations, but owing to the risk of fire should not be erected in towns.

Bonding is the arrangement of bricks in a wall so as to bind it securely together. With the English bond the sides and ends of the bricks alternate in every course. With the Flemish bond a course of sides alternates with a course of ends. Walls so constructed should be 9 inches thick or more. An external wall may stand on a footing so as to distribute its weight, and the footing should rest on a stone or concrete foundation (Fig. 89).

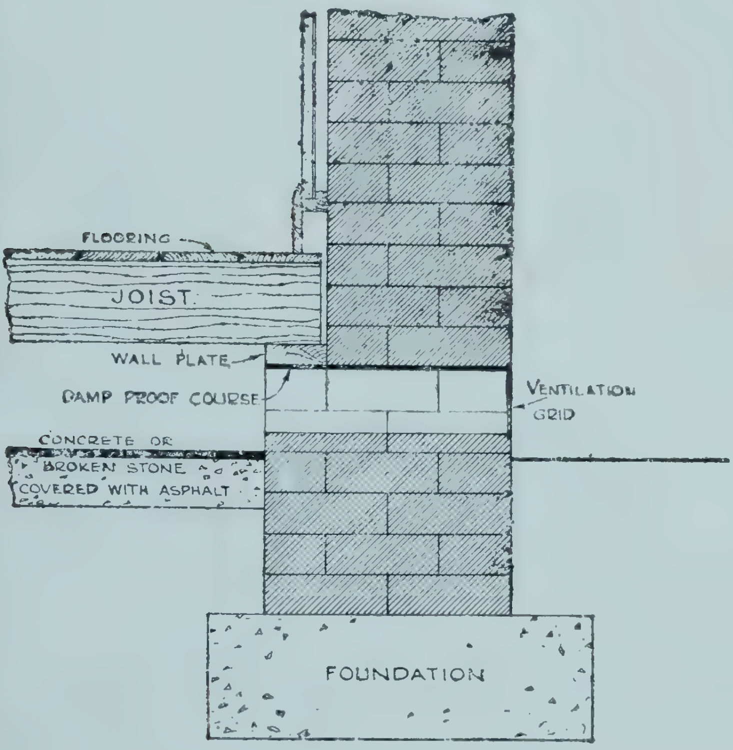

Fig. 89.—Footing of Wall.

Mortar is composed of one part of slaked lime to three of sharp sand. Cement consists of chalk and clay, calcined but not clinkered, and ground to a fine powder. Portland cement is of similar composition but the ingredients are burnt to clinker. Concrete consists of cement and sharp sand mixed with broken stone, brick or clinker.

Party walls are of lighter substance than external walls but should be equally incombustible. They are usually carried up to the under side of the roof but in London must project above it. Party walls, as well as partitions within houses, should as far as possible be made sound-absorbing.

Roofs should be covered with incombustible and impervious material. Slates, tiles, stone slabs, asbestos roofing and metals such as zinc, lead and copper answer this description. Slates are the staple roof covering in Britain: tiles and stone slabs have a local vogue. Thatch, wood shingles and tarred felt involve a risk of fire. A slate roof should have a pitch of not less than 30° and the slates should be nailed through felt on boarding. A tiled roof requires heavier timbering. It should have a pitch of 45°. There should be lead flashings where the roof joins a chimney head, skylight or dormer window.

Boarded floors for rooms are laid on joists. The boards should be grooved and tongued. On upper floors the joists are made use of to carry the laths for subjacent ceilings. Parquetted floors consist of blocks of wood fixed by tar and asphalt on a stratum of concrete. There has lately been a considerable development in floor finishes, including magnesite, cement-wood, rubber-latex and calcium sulphate. Unit laid floors are exemplified by cork tiling, rubber tiling, clay tiling and plywood. Entrance halls, bathrooms, kitchens, sculleries and larders should be floored with tiles or other impermeable material. In modern building construction it is not unusual to lay ground floors directly upon concrete with an intermediate layer of bituminous felt which affords both thermal and accoustic insulation. Ground damp is prevented in such cases by the insertion of a damp-proof 'membrane' of asphalt, pitch mastic, bituminous emulsion or latex-cement.

DAMP

In the humid climate of Britain damp is prone to invade houses wherever it can find an entrance. The unwanted moisture causes structural damage, ruins furnishings and reacts detrimentally upon the comfort and health of occupants. The presence of moisture in external walls renders houses cold by accelerating the leakage of their warmth outwards. The damp rooms feel cold to their occupants owing to the continual evaporation of moisture and consequent withdrawal from surfaces of the latent heat of vaporisation. Also, when the attempt is made to warm damp rooms they respond slowly, since much of the energy of the heat applied is expended in vaporising water. The low standard of comfort experienced in this chilly environment depresses the vital forces and weakens resistance to disease. Tuberculosis has been found associated with damp, and there is agreement that damp houses favour the occurrence of rheumatism.

Damp may ascend into houses from the ground or penetrate their walls from without or effect an entrance by way of the roof. Condensation damp and building damp also occur.

Ground Damp. The first precaution against ground damp is to choose a dry site or under-drain a wet one. Vegetation-bearing soil should be excavated for a distance greater than that to be occupied by the actual foundations of the house. To prevent moisture-laden ground air from rising into a house the *solum* within the external walls should be covered with asphalt and concrete 4 to 6 inches thick (Fig. 89). The under-floor space between the lowest joists and the asphalt or concrete layer should be at least 6 inches clear. A damp-proof course of impervious material should be inserted in all foundation walls below the ground-floor joists and not less than 6 inches above ground level. The course may consist of sheet lead, slates laid in cement, asphalt or Caithness flagstone. Bituminous felt of superior quality is largely employed also. Under-floor ventilation should be provided by means of ventilating grids or air bricks set at different levels in opposite walls of the under-floor space so as to pass air freely through it. Without this precaution the flooring and adjacent timbers may develop dry rot from the proliferation of the fungus *Merulius lacrimans.* Drops of moisture show on the weeping fungus, but the ruined woodwork has a dry appearance (Fig. 90). Woods cut in the sap and imperfectly seasoned are most subject to this invasion. If the lowest floor is below ground level the earth round the building should be excavated to form a dry area. The outside wall to the depth of the area may be coated with cement and waterproofed. An alternative plan is to construct a hollow wall with two damp courses.

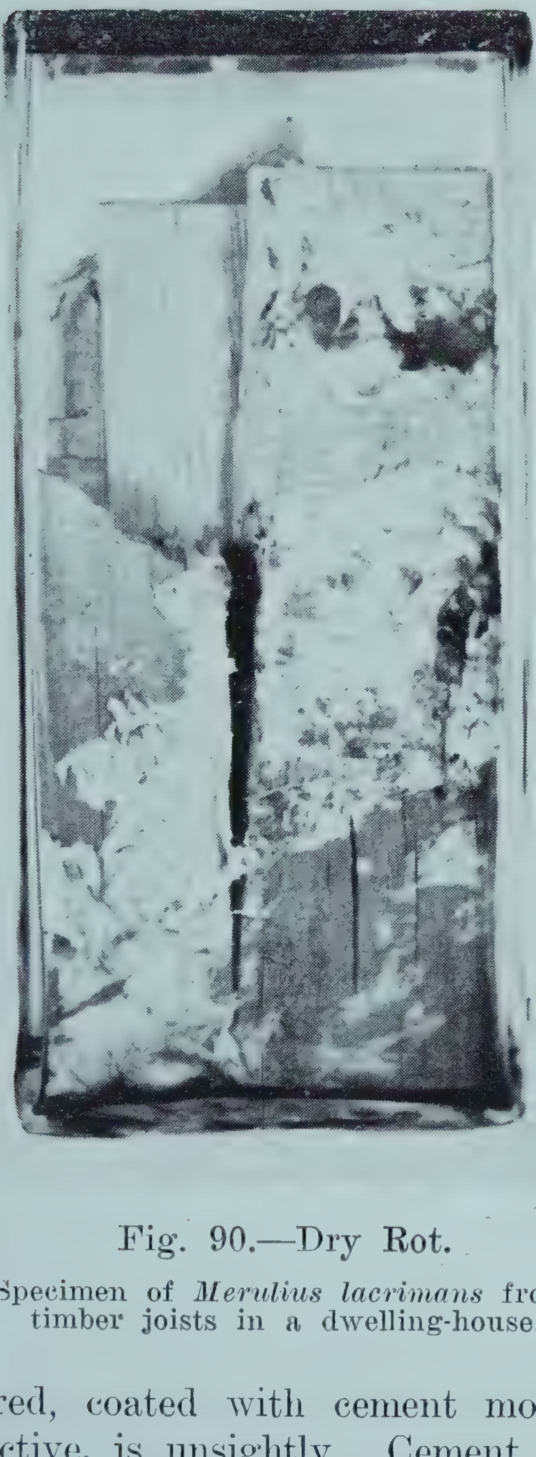

Fig. 90.—Dry Rot.

Specimen of *Merulius lacrimans* from timber joists in a dwelling-house.

Wall Damp. In order to exclude driven rain external walls may be oil-painted, slated, tiled, tarred, coated with cement mortar or built double. Tarring, though effective, is unsightly. Cement mortaring may be set off with 'pebble-dashing' or 'rough-casting.' Double-walling should be of the 11″ brick cavity type with an interval space of 2 inches. The galvanised iron ties which bind the two walls together are made with a twist presenting a free edge downwards so that gathered moisture may drip clear. Care should be taken to prevent mortar from lodging upon them, or they will serve as bridges to convey moisture from one wall to the other. Where the wall is single its internal surface may be wood panelled or compo boarded, or it may be strapped or battened and lath and plaster applied. Choked or sagging eaves-gutters and broken or rust-worn down-spouts will allow roof water to run down the walls. Rain-water fittings should be kept in good repair and painted at intervals. Window sills should project and be grooved or throated along the length of their under side so that water collected upon them will drip clear of the wall.

Roof Damp. Damp occasioned by too narrow eaves or defective eaves gutters may enter the house from above. Chimney heads and parapets should be made waterproof by cementing or otherwise. Wherever slates are missing or displaced, or roof spars sunk or uneven, rain is ready to make its way. Another cause of roof damp is the stripping by gales of the lead flashings which protect joins between slate work and chimney heads, skylights or dormer windows. A double course of slates at the eaves is prophylactic of edge damp in roofs.

Condensation Damp. In the case of occupied rooms moisture may condense upon the inner surfaces of walls if finished solid. With adequate warming and ventilation such condensation is less likely to happen. It may be prevented by lathing and lime plastering.

Building Damp. In new houses damp may appear owing to water in plaster and other materials making its way to the surface. New-built houses should not be occupied until this kind of dampness has ceased to be obtrusive. Thorough firing of rooms will speed their drying.

INTERIOR ARRANGEMENT

In the arrangement of house interiors every effort should be made to safeguard amenity and convenience of working.

There should be no steps in passages, and no step up or down at the entrance to a room. No room or apartment, however small, should be entered by a low doorway. No staircase should be helical: all should run in straight flights between rectangular stepless landings, and all should be equipped with hand rails. All passages and stairways should enjoy good natural lighting.

Every house should have its kitchen well lighted. A gas or electrical cooker should be used in lieu of, or in addition to, a kitchen range. There should also be a scullery with sink. A small scullery is best: it offers most convenience. Every house should contain a well lit and well ventilated larder, with wire gauze or other window protection, facing northerly or easterly.

Hot and cold water should be laid on. The water may be warmed by the coal fire in the living room or by means of an electrical immersion-heater in the hot-water tank. There should be a fixed bath in a bathroom. The w.c. compartment should contain a wash-hand basin also. The compartment should have at least one external wall and a window opening to the outer air. Proper arrangements should be provided for washing and drying clothes. A rotary electrical washer is a useful aid.

Other essentials are ample cupboard and wardrobe accommodation, preferably built-in, and a conveniently situated fuel store. A service hatch between the kitchen and dining-room is a convenience.

These facilities should be combined with arrangements for ventilation, warming, lighting, water supply, dry refuse removal and sewage disposal in compliance with what has already been said on these subjects in previous sections.

INSANITARY HOUSES

Houses which are sufficiently lacking in the requirements above specified are insanitary houses and liable to be classed as unfit for human habitation. Among the most significant sanitary defects of houses are included 'lack of air space or of ventilation, darkness, dampness, absence of adequate and readily accessible water supply or sanitary accommodation or of other conveniences, and inadequate paving or drainage of courts, yards, or passages.' Under the Housing Act, 1936, local authorities are empowered to take action with regard to such houses, or areas composed of such houses, if inhabited by persons of the working class. They are guided in each case by an official representation made by their medical officer of health or sanitary inspector.

Insanitary Premises. If a house is unfit for human habitation but can be made fit at reasonable expense the local authority call upon the owner to repair it. If he fails, they do the work and recover expenses.

If a house is unfit and cannot be made fit at reasonable expense the local authority so inform the owner, who may offer to make it fit. If he does not offer, or offers and fails, the local authority make a demolition order and the house is demolished. If the house is part of a building otherwise good, they make a closing order instead.

Insanitary Areas. If an area is composed of houses unfit for human habitation or so ill arranged as to be injurious to health, the local authority, having satisfied themselves as to the rehousing of the occupants concerned, declare it to be a clearance area, and then after sundry procedure make a clearance order and the houses are demolished. Or else they purchase the land and themselves demolish the houses.

Redevelopment Areas. If an area in a town is not so insanitary as to require clearance but contains fifty or more working-class houses, at least one-third of which are overcrowded or fit only for demolition, the local authority may declare the area to be a proposed redevelopment area, and after sundry procedure may take steps to redevelop it.

The Housing Act, 1936, expressly forbids the erection of back-to-back houses as dwellings for the working classes, unless in tenement property approved by the medical officer of health. It also empowers the demolition of obstructive buildings, which are injurious by their proximity to other buildings.

OVERCROWDING

The overcrowding of people in dwellings is fraught with danger, since under such conditions minor sanitary and structural defects assume a serious aspect, while major defects are aggravated. The path of the spray infection is shortened and communicable disease in general is more easily spread than in more spacious surroundings. Socially, overcrowding is still more mischievous. It means a propinquity which destroys the amenity and convenience of life and, where it involves inadequate accommodation for the separation of the sexes at night, it exercises a degrading influence especially upon the outlook of children.

For the purposes of the Housing Act, 1936, a house is deemed to be overcrowded if it fails to satisfy all three of the standards cited below, the first of which relates to the separation of the sexes at night, the second to the number of persons per room and the last to the number of persons according to floor area :

SEX SEPARATION

A house is deemed to be overcrowded if any two persons, 10 years old or more, of opposite sexes not living together as husband and wife, have to sleep in the same room.

NUMBER OF ROOMS

Rooms.	*Maximum Number of Persons.*
One	2
Two	3
Three	5
Four	7½
Five	10

If the rooms are more than five, add 2 persons for each room over five.

FLOOR AREA

Square Feet.	*Maximum Number of Persons.*
110 or over	2
90 up	1½
70 up	1
50 up	½
Under 50	0

A room under 50 square feet is to be disregarded. A child under 1 year of age is not taken account of. A child of 1 year upwards but under 10 is reckoned as one-half.

It was recommended by the Central Authorities in 1944 that living rooms were not to be taken into account in making the above assessments.

It is the duty of local authorities, having ascertained the incidence of overcrowding in their areas according to the triple standard, to take steps for its abatement by the provision of rehousing for the overcrowded persons of the working class.

In Scotland the procedure for dealing with insanitary single houses, insanitary areas, redevelopment areas, and overcrowding, including the triple standard, is due to be carried out precisely as outlined above but under the Housing (Scotland) Acts, 1930 and 1935.

INSPECTION OF HOUSES

It is an important duty of a Sanitary Inspector employed by a local authority to make from time to time an inspection of houses in his area with a view to determining whether they are unfit for human habitation, and on completing such inspection to submit the facts ascertained and their implications in the form of a report to his local authority for their guidance in any action deemed to be appropriate.

Items which may usefully figure in the above-mentioned report are such as the following:

Date and time of inspection.

Locus. Address of house and location in street.

Name and address of owner and also of his factor or agent.

Names of tenants and occupiers and accommodation occupied by each, and rents charged.

Environment. Street orientation, *e.g.* N. and S., and aspect of house by compass points, *e.g.* facing W.

Proximity of house to other dwellings or factories or commercial buildings.

Approach to house. Whether open space round, and whether traffic noise.

Amenities. Proximity of facilities for recreation (1) outdoor and (2) indoor.

Whether play space, gardens or sports ground.

Traffic category of adjoining streets and roads.

External Structure. Note condition of chimney heads, roof, rones, rain-water pipes, soil pipes and waste pipes, and walls, front, rear and gables. Observe whether damp course is incorporated and note type and condition. Note location of evidence of dampness at ground level, at pipe joints and at eaves. In respect of walling, mortar joints or cement rendering should be noted. Likewise the provision made for sub-floor ventilation.

Note presence and condition of outbuildings and their use, *e.g.*, washing house, coal house, water closet, etc. Observe whether rear area is wholly or partly paved or soft and miry.

Internal Structure. Observe state of passage and staircase and whether adequately lighted and ventilated. In respect of the condition of the individual houses, note number of apartments, and their arrangement: the sufficiency or otherwise of ventilation and lighting (position and size of windows in relation to floor areas): evidence and extent of dampness, condition and repair of walls, floors, ceilings, windows, etc.: also evidence of infestation by vermin or insects: the position, type and number of sinks, water closets (whether for use by one family or common to others): the source and sufficiency of water supply (whether from cisterns or direct from mains): artificial light, type and condition of fittings: the bathroom facilities and condition: hot water supply and how obtained: the arrangements for the storage of clothes, etc., and food, and adequacy of ventilation of these: the provision and situation of coal or fuel store and the means provided for the disposal of household refuse. Consider whether drainage is adequate.

A statement, generally tabular, showing family numbers, ages and sexes of children, and extent of overcrowding, should be appended, and may include the existence of shops or stores, etc., in the property.

It should be remembered that inspection is made in order to ascertain whether the house is 'unfit for human habitation' and that an accurate assessment is reached on the cumulative evidence obtained by a thorough and detailed survey.

The Medical Officer of Health or Sanitary Inspector has power of entry to survey and examine houses occupied by the working classes, but 24 hours' notice of intention must be given to owner and occupier.

The Master of Works of a local authority or other designated official inspects new buildings, including houses, during erection. On completion of the work, occupation is permitted on his certificate.

REHOUSING

Persons of the working class living in overcrowded houses or in houses marked for demolition might in a few cases be rehoused in dwellings vacated by other tenants. They were however for the most part accommodated in new houses specially erected by the local authority with the aid of a Government grant. The site of the new houses so provided was either (1) Surburban, that is to say, on the outskirts of the town and often some distance away from the former haunts of the people, or (2) Central, that is to say, situated well within the town and near the old home.

Surburban Rehousing was the method preferred, the favourite style of dwelling being the single or paired cottage, or the two-storey block containing four houses, usually spaced out and occupying a good deal of land. The air and sunshine of the suburb were good for the children, who could in addition play with safety in the gardens attached. These were undoubted gains. On the other hand owing to the cost of land and other items the rents of the cottages often reached a figure which strained the resources of families. Further, the wage earners in a household might now be miles from the mill or factory and might have to incur expenditure daily in order to get to work, while at the same time the housewife lost touch with the cheap markets, to which she had been accustomed, and had to buy the family food at suburban prices. At Stockton-on-Tees, as revealed by G. C. N. McGonigle, rehoused slum dwellers on a municipal housing estate were living on a physiologically inadequate diet, and had a higher death rate among them than the people left behind in the slums. In Glasgow too an enquiry elicited that in a rehousing area the respiratory morbidity was higher than in the original slum, owing to families sleeping all in one room. Having regard to all the circumstances it became clear that suburban rehousing, while doubtless suited to certain types of tenant, was not the only way.

Central Rehousing near the former homes of the people, on account of the lack of readily available land in the populous parts of cities, could not be effected by means of cottages or small blocks as in the suburbs. It involved the use of flatted tenement buildings, which had to be several storeys high if a substantial proportion of the displaced were to be accommodated. In some large cities tenement buildings had for long constituted the staple housing accommodation of the artisan. Owing to their massive construction many of them have far outlived their period. They have degenerated into slums and their old age is without honour. By contrast, more recently, modern flatted properties, planned on hygienic lines and erected on cleared sites, have been found adequately to serve the purposes of both health and convenience in the rehousing of displaced working-class tenants. Since the wage earner can walk to his work without outlay on transport, and the housewife has easy access to cheap food supplies, a family thus centrally rehoused can pay a higher rent without having to economise in food. Flatted buildings of the type described, usually 4 storeys high, are in occupation in London and elsewhere.

POST-WAR HOUSING

Views have been expressed on post-war housing which reflect a more generous understanding of the basic requirements of domestic life than is exhibited in housing statutes now current in this country. As regards overcrowding, it has been urged that the ‘triple standard’ of the Housing Act of 1936, as well as of the equivalent Scottish enactments, was fixed too low. Infants were rated as 0 and children as $\frac{1}{2}$. Both, it is held, should be accounted fully qualified ‘persons,’ and the number of ‘persons’ in a house should be not more than 2 per bedroom, other rooms being disregarded. Further, no bedroom in a house should be of less floor space than 120 square feet. The standard house will be the family house, for father, mother, and 3 children. It should contain a living room, parlour, kitchenette or kitchen-scullery, larder, bathroom and 3 bedrooms. The larder, with a view to the adequate storage of food, should have an area of 40 square feet. The storage of fuel also should be provided for. In housing schemes some larger houses may be required and some smaller houses permitted. Special accommodation may be arranged for aged people.

It is agreed by most (1) that the cottage type of building will best adorn the rural landscape, and conceded (2) that flats may be included in urban housing schemes.

Cottages may be built of one or two storeys. They may be self-contained in their own plot of ground, or they may be semi-detached. Cottages for rural workers are at present sprinkled casually over the country-side, or sited singly and aloof in remote unfrequented positions. Such a dispersion may have to continue in, say, the case of shepherds, but the generality of rural cottages in the new era should be grouped to form villages. Here the worker and his family can develop the social spirit and share in the activities of an organised community. Other benefits which may attend on grouping are a supply of wholesome water piped into houses, the convenient disposal of sewage, and an electricity service for lighting and, it may be, also cooking and house warming, though the cottage in the country is one of the types of habitation where the burning of wood, peat or bituminous coal would be unobjectionable. An amenity, by comparison with cart tracks, will be the ‘made road’ serving the village, and offering facilities for transport by bus or bicycle. The equipment of the cottage should include a bicycle shed and a place indoors to house a perambulator. Any internal arrangements of cottages not specifically mentioned above should conform in principle to what has been said in a previous reference[1] to the subject.

Flats. The flatted type of residential building of 4 storeys or thereby, which as already noted was found useful for rehousing, will doubtless figure largely in post-war reconstruction by reason of its ability to accommodate more persons on a given urban site than is possible with self-contained houses. For practical purposes its absorption capacity varies as the number of its storeys so that in large cities, where the problem is the re-development of central areas, the provision of a proportion of multi-storey flats is the obvious solution. Such flats will require electrically driven lifts, centrally placed in such a manner as to serve the whole building, and in this and other respects will not only supply the essentials of service but will also meet the demands of comfort and convenience. The button control safety type of lift is useful where there are children.

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[1] Page 368.

As the serenity of flatted life is liable to be broken in upon by sounds such as loud wireless or children playing, which remind tenants of the existence of their neighbours, the prevention of such noises bulks considerably in the construction and management of flatted properties (Fig. 91). In busy localities the continuous hum of street traffic may produce in buildings a threshold noise, estimated at 20 to 30 phons, which helps to mask sounds from other sources. If, on the other hand, the neighbourhood is quiet, these intruding sounds become audible and vexatious. Structurally, in order to prevent the reverberation of air-borne noises, partitions may be doubled, with 2 inches of air space between, and set on a cork lining or pads of glass silk or steel wool. In order to prevent the transmission of the clatter of footsteps, floors may be covered with thick carpeting, or thick linoleum may be laid in mastic on cement screeding. In order to prevent the festive tenant who turns night into day from disturbing the slumbers of serious-minded persons, bedrooms should be located only under bedrooms and living rooms only under living rooms. They should not alternate in vertical tiers. Solid brick structures are in general much less prone to transmit sounds than metal-frame buildings.

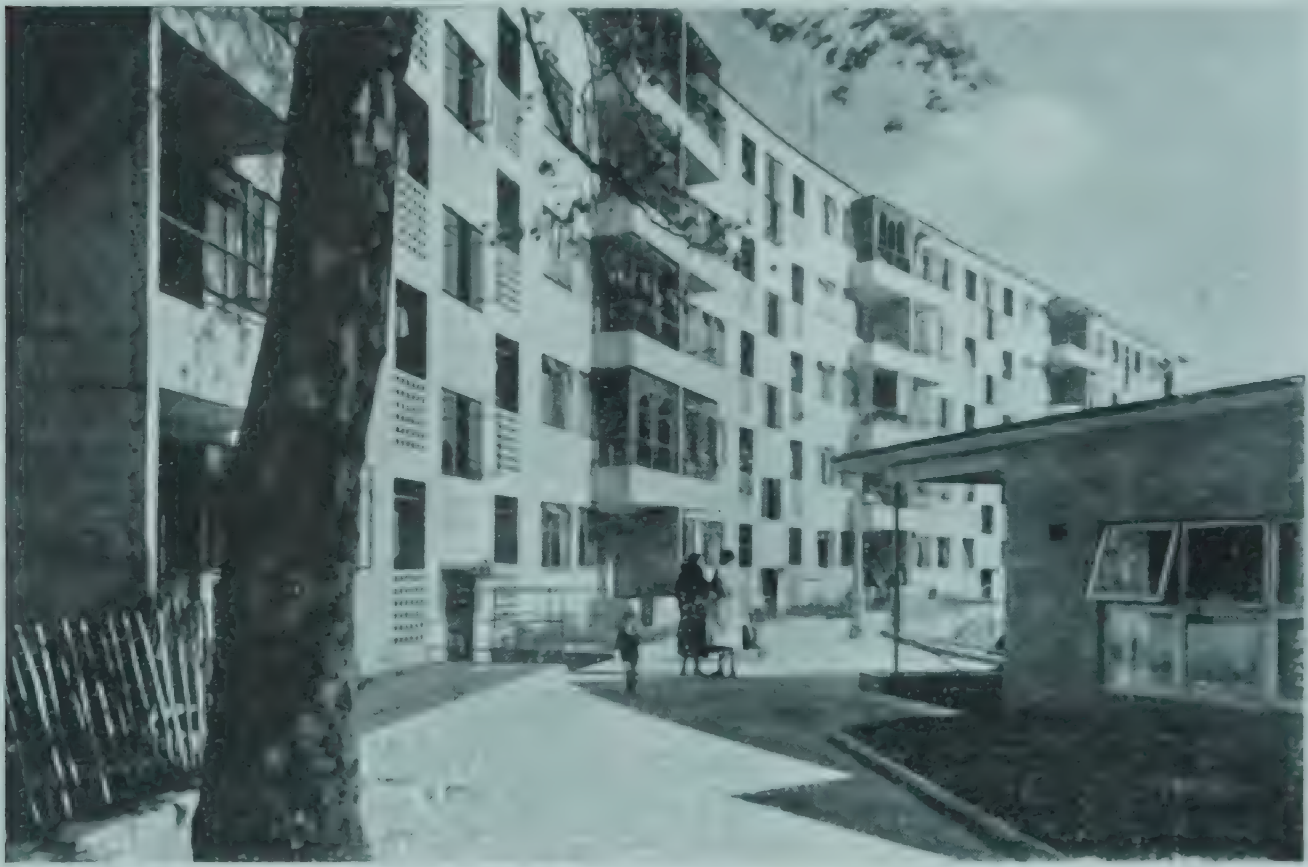

Fig. 91.—Modern Flats. Community Centre on right.

Management also can do much. Such fittings as locks, latches, lift gates and electrical switches should be noiseless when put in, and maintained in noiseless repair. 'Water hammer' and other sounds, which carry readily along pipes, should be promptly dealt with. In very select flats dogs may be forbidden, and the early morning newsboy and milkman required to wear soft shoes.

Large blocks of flats may be warmed on the central plan with hot water circulating from coke-fired boilers, or locally by means of electrical radiators, or gas fires where gas is available, or smokeless fuel if there are grates. The domestic supply of hot water may be central also, use being made of waste heat from an adjacent factory, or local, using electricity or gas. All rooms in the building, including a position in each flat for a refrigerator, should be pointed for electricity. If there is a community restaurant any cooking required at the flats can be done with electrical or gas cookers. The Garchey system of refuse disposal has been found satisfactory for large buildings such as multi-storey flats. It has the merit of being able to dispose of the ash resulting from the combustion of smokeless fuel.

Internal arrangements of flats not specifically mentioned above should, as with cottages, conform to what has been said in the previous paragraph on the subject.

Planning our New Homes. This is the title of the Report by the Scottish Housing Advisory Committee, in which they make recommendations as to the design, lay-out and other features of the proposed post-war houses. Portions of the Report are summarised here.

The cottage type of dwelling is approved, as is also for large cities the multi-storey flat up to 10 storeys. The 2-storey 4-house block, hitherto much in evidence, is not esteemed. Flats of 1 or 2 rooms in blocks not more than 2 storeys high are regarded as suitable for aged persons. Small houses or flats for single women should be fully equipped for labour saving.

In the standard house of 3 bedrooms the largest bedroom should measure 150 to 160 square feet of floor area, and each of the two subsidiary bedrooms 120 square feet. The living room of such a house should have a floor area of 190 square feet. Other rooms should be a parlour and a kitchen-scullery. Instead of a parlour there may be a curtained-off dining annexe. In addition to a kitchen-scullery there should be a utility room for household washing. The width of internal stairs and passages should be from 3 ft. 3 ins. to 3 ft. 6 ins. Ceiling heights should be for ground-floor rooms 8 ft. 6 ins. to 9 ft., and for upper rooms 8 feet.

All bedrooms should have independent access to a hall or passage. Where there is not direct communication between the living room and the kitchen, a serving hatch should be put in. The w.c., wherever situated, should have a wash-hand basin in the same compartment. In electrically lighted houses a bulb for supplementary lighting should be fixed in the kitchen over the sink or work table. Individual verandah balconies are approved for flats.

An abundant water supply piped into every house is a basic essential. The house pipes for soil and waste water should be on the one-pipe system, and internally sited. The latter reform will prevent the pipes from getting frozen in winter. It will also free the external walls of the houses concerned to display any graces which they may possess.

If coal is burned, the fireplace in the living room should be built into an internal wall. District heating too is recommended for house warming. It is large scale central heating. Every house has hot water laid on and all rooms excepting kitchens are provided with hot water radiators. For multi-storey flats, community laundries are viewed with favour and the Garchey system of refuse disposal is commended.

Adequate storage accommodation in or about houses is an important provision. The larder in rural houses should have a floor area over 20 square feet. In town houses it may be smaller. Where there is gas or electricity a refrigerator may be installed. There should be a convenient fuel store, a linen cupboard, a coat cupboard, a bicycle stand and a space for a perambulator. A multi-storey block may be able to maintain a garage, the bays in which would be rented to tenants owning cars or motor-bicycles. All out-buildings should appear in the building plan. It should not be left to tenants to cumber the site with shacks. Box window-seats in rooms are suggested for keeping children's toys.

The staple building material for the houses will be brick, with stone locally, but speedier methods such as 'poured cellular concrete' are being investigated. There will be standardisation in the construction. That is to say that parts and fittings will be of standard sizes and patterns. There will also be prefabrication. That is to say that the parts and fittings can be brought to the building site already assembled. It is thought likely that the metal-frame casement window will have an increasing vogue over the timber frame sash type. The latter, where used, should be made to swing in for cleaning. The view is expressed that 'sound-insulation is of at least equal social significance to any other factor in construction.'

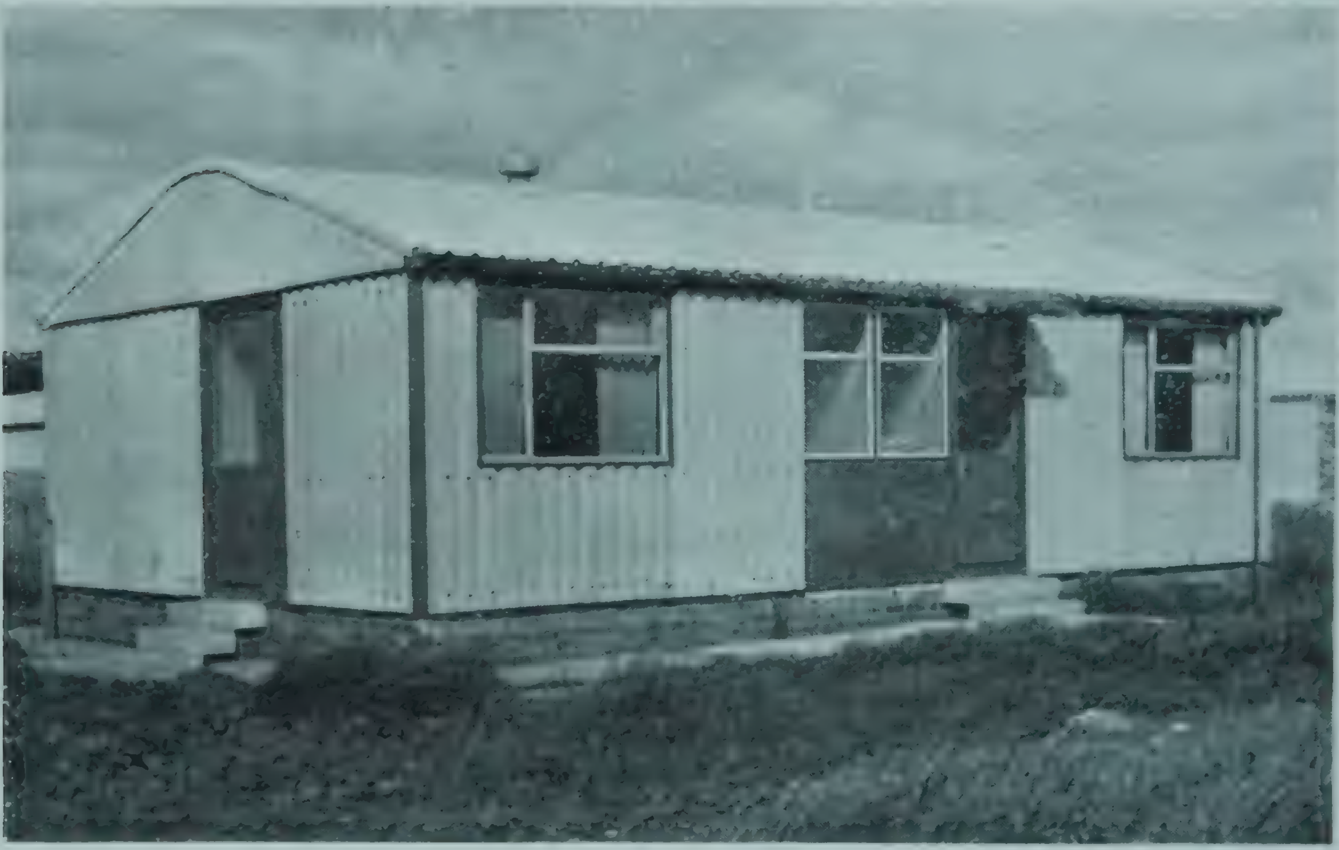

Fig. 92.—Arcon Bungalow.

Three apartment type, constructed of corrugated asbestos sheets lined with fibre board, assembled on a concrete foundation, with dwarf walls to floor level, and roofed with corrugated asbestos sheeting. Internal details are in the main as for the Tarran Bungalow (Fig. 93).

In laying out housing estates the aim should be to group the area in residential units, each leading its own social life and providing its own communal services and recreations. It is suggested that 400 to 450 flats could be planned on a compact community basis.

New type houses of the permanent and semi-permanent variety are exemplified by the Easiform house with concrete double walls cast *in situ*, the Norwegian and Swedish timber houses, the Dennis-Wild Steel Frame house, the Weir Metal Clad house and the Thorncliffe Cast Iron house. Concrete and steel-clad forms are the most stable. The risks of fire and vermin are roughly equal to those in houses of normal construction.

PREFABRICATION

The urgency of post-war housing needs has dictated a Government policy which includes the provision of both permanent and temporary houses. The latter category, which have a scheduled life of ten years or less, are supplied to local authorities by the State and are erected on council-owned sites by the Ministry of Works. Statutory provisions concerning these structures, which are in most of their parts 'factory made,' are contained in the Housing (Temporary Accommodation) Act, 1944, and are summarised in a related Memorandum published by H.M. Stationery Office. Favoured types include the Ministry of Works Pressed Steel Bungalow, the Arcon Mark V Bungalow (Fig. 92), the Seco Bungalow and the Tarran Bungalow (Fig. 93). The houses are strictly utilitarian and have no aesthetic pretensions. All types comprise living room, two bedrooms, kitchenette and bathroom. The houses are erected from completely prefabricated units and are built on brick dwarf walls superimposed upon concrete foundations. This practice involves the use of timber or light rolled-steel framing to take the sides, which are either of asbestos sheets or waterproof concrete panels. Plaster boarding is employed for internal surfaces, and a variety of insulation

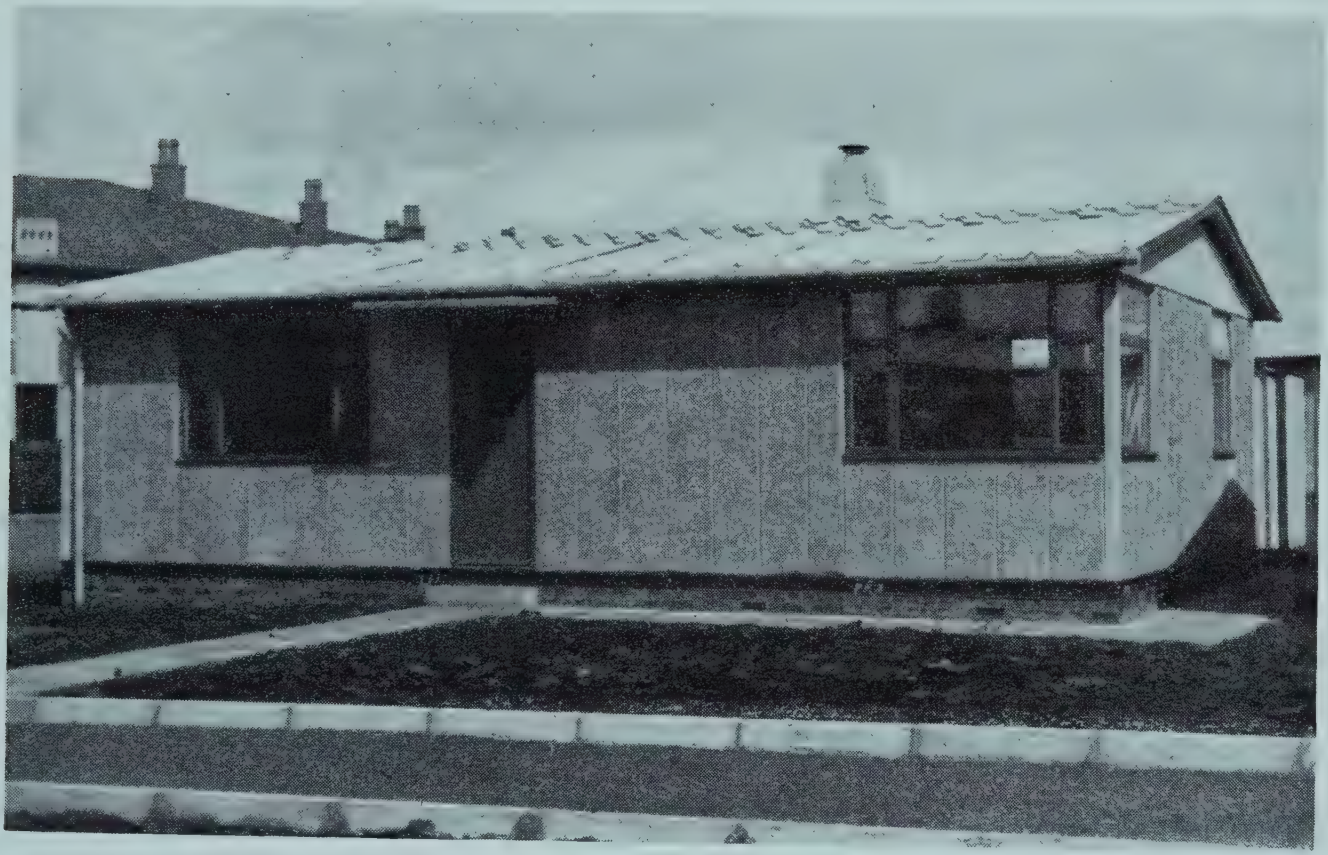

Fig. 93.—Tarran Bungalow.

Three apartment type, constructed of flanged concrete panels lined with 'Gyproc' or fibre plate, assembled on a concrete foundation, with dwarf walls to floor level, and roofed with corrugated asbestos sheeting. Central heating is effected by a convection stove and an electric immerser is provided for hot water. The bedrooms have built-in furniture, and the kitchenette is fitted with a refrigerator.

materials are used as packing to check thermal losses. Much attention has been devoted to the question of fittings for the houses, and many ingenious appliances have resulted. Drainage is of a simple type and waste water may discharge over an open gully. Both piping and fixtures are standardised. The erection of prefabricated homes requires the services of skilled 'assemblers,' though fewer tradesmen are needed than in the case of permanent buildings. Initial costs are relatively higher than for traditional methods, but they decline as production increases. The principle of prefabrication, hastily developed as an emergency measure, is now being actively expanded, and it is not unlikely that many of its features both of fabric and design will in time be incorporated in permanent building construction, thus combining the best qualities of both systems to provide the 'ideal' house of the future.

Design of Dwellings. This is the title of the Report, dated 1944, by a Sub-Committee of the Central Housing Committee for England and Wales, in which recommendations are made as to the design, planning, layout, construction and equipment of dwellings for the people throughout the country. Attached to the principal report is the report of a Study Group on site planning.

The principal report emphasises that good design in housing schemes is fundamental. Too often in the past, it says, the most that was hoped for a Council housing estate was that it should be unobtrusive. The hope is cherished that, in the future, local authorities will set out with the intention of adding positively to the beauties of town and country.

Local authorities should continue to concentrate on the provisions of the 3-bedroom house interspersed with other types. In all Council houses convenient provision must be made for the taking of meals. These arrangements are important because in a working-class household it is not unusual for meals to require to be served as often as seven times in the day. This number is made up of two breakfasts, teas and suppers for the husband and children separately, together with one lunch for the children.

In the country new cottages should be grouped to form villages, or located in or near villages which already exist. As new cottages are more conspicuous in the country than in the towns, cottage design in rural areas should receive special attention.

Flats, while not well suited for families with children, are less objectionable for other persons, and a mixed development of 3-bedroom family houses and blocks of flats may be recommended. Such a scheme makes possible a more varied grouping of buildings round nodal points.

The water-borne system of refuse disposal for flats is classed as in general scarcely a practical proposition, though for large-scale developments it merits consideration. Automatic passenger lifts are recommended for all blocks of flats containing more than 3 storeys above ground level. The cost of such installations has worked out for Quarry Hill, Leeds, at an average addition of 7d. per week to the rent of each flat on the estate.

In the matter of laundry facilities for flatted properties a preference is expressed for the communal laundry as against arrangements for doing such work in the individual flats. A communal laundry, whether providing for many women at a time or only, say, half a dozen, can function with complete efficiency provided that each woman has her separate working unit for washing, boiling, rinsing, drying, mangling and ironing. If for any reason it is resolved to have washing done in each flat, the washing equipment should be tacked on to the bathroom, not to the kitchen or scullery, and a scheme of communal drying at the service of all the flats should be devised.

Aged persons are best housed in small self-contained flats in 1 storey blocks arranged in little groups, or else in existing buildings adapted as hostels. For single persons a sufficient provision of small self-contained flats should be made in order that the evils of sub-letting may be repressed.

For difficult tenants special accommodation has been set aside in Scotland, Holland and elsewhere. The Report however does not favour the segregation and intensive supervision of these detrimentals. Better, it says, that they should undergo a process of education for some time before they move into their new homes.

In the report of the Study Group it is said that in site planning every effort should be made to avoid a formless and non-significant layout. A nexus of roads on a suburban site, curling like country lanes for no apparent reason, will produce building difficulties and create hazardous road junctions without exhibiting any easily apprehensible order or pattern. The other extreme, rigidly in excess, is equally objectionable. The stiff grid-iron arrangement tends to monotony and should be diversified.

Open formations for housing estates have their merits, but an endless succession of identical houses with identical spaces between them set down over a wide area would be too uninspiring. It is suggested that close grouping to form key points would help to enliven the prospect.

The terrace is one of the most useful forms of close grouping. Though at present many people are prejudiced against the terrace house, it is mainly because they have never lived in a well-designed modern terrace. The chief grounds of censure have been the noise, the shortage of windows and the difficulty of back-door access. All these inconveniences, it is claimed, are readily remediable, and, if removed, would open the way to a greater vogue for terraces. If so, it will be a gain, for the terraced vista is conducive to civic pride.

TOWN AND COUNTRY PLANNING

The rebuilding of Paris by G. E. Haussmann in the time of the third Napoleon inspired the remodelling of many other cities on the Continent of Europe. Britain however appears to have remained unimpressed. With some brilliant exceptions, such as J. Nash's Regent Street, the New Town of Edinburgh and Corporation Street in Birmingham, urban development went on for the most part haphazard and uncontrolled. Towns expanded by the simple process of spilling over into the adjoining district, creating round them a formless no-man's-land which was neither town nor country. Then ribbon building began, houses being lined out along the arterial highways leading from the cities. The Housing, Town Planning, etc., Act of 1909 and the Town Planning Act of 1925 were to some extent instrumental in regulating the spilling over, but the mischief of ribbon development increased as motor transport extended and houses were permitted to be erected even along the by-passes made for high-speed through traffic. It came to be realised that the country itself was imperilled, and the planning movement which had begun in the interests of the towns, to save them from the incubus of impossible suburbs, broadened into an aspiration to save the country as well.

These aims found expression in the Town and Country Planning Act of 1932, and the Restriction of Ribbon Development Act of 1935, the former of which gave power to towns to re-plan their amorphous suburbs, while the latter forbade the erection of dwelling houses within 220 feet of the mid-line of certain roads unless with official consent. Not much has been achieved by these two Acts. Their story, in the words of a recent Report, 'has been one of high hopes followed by disappointment.'

When the expansile force of a city threatens spilling over, it should be remembered that 'hiving off' is a possible alternative. A group of suitable trades could be moved out from the city to a country area where power is within reach, and a new all-industrial model town built round them there. Towns of this type already exist. Saltaire, the pioneer effort of 1853, enshrines the name of its founder, Sir Titus Salt. Later in the nineteenth century came Bournville and Port Sunlight. All were specially laid out by employers to fulfil the requirements of industry and at the same time minister to the well-being of workers. The garden cities, Letchworth and Welwyn, although otherwise promoted, serve the same objects. The new towns of the future are being ushered in by the New Towns Act.[1]

POST-WAR PLANNING

All previous effort bids fair to be outpaced by the planning now contemplated for the reconstruction of Great Britain after the Second World War, the aim of which is to provide, *inter alia*, healthful, convenient and attractive homes for the people. Nation-wide in its range, the scheme embodies a long-term policy, up to 50 years or so, into which the early restoration of the devastated areas should be made to fit. An outline of such a plan has been drawn for Greater London by a Committee of the Royal Institute of British Architects. It is cited here as conveying to the mind a valuable impression of the dimensions, range and complexity of the various issues involved.

Greater London in the plan (Fig. 94) is of a circular configuration, pivoted on, but excluding, the City. It extends from Barnet in the north to Banstead in the south, and from Erith in the east to Staines in the west. It measures some 30 miles across. There will be a First Ring Road enclosing the centre of the area, and a concentric Second Ring Road surrounding the First. Next, at a greater distance, comes the Circular Road outside the Second Ring Road, and finally the Orbital Road on the circumference. Starting for the most part from the First Ring Road, trunk roads, cutting the concentric roads, will lead radially out to the perimeter, and so on to Norwich, Brighton, Portsmouth, the Midlands, Holyhead and the North. Roads within the Second Ring Road will be speed-limited, and will have cross-overs. For the Second Ring Road, the Circular Road, the Orbital Road and the trunk roads there will be no speed limit.

Every trunk road will run in a continuous park-way, a broad tract of greenery bringing vital freshness in from the open country. The park-ways, however, will not consist solely of untrodden turf. They may be used for the purposes of sport and recreation, and to provide market gardens or allotments, and for the siting of such buildings as schools, hospitals and welfare centres. They may also carry the railways of the area, especially if electrified. The trunk roads will constitute barriers which no housing plan will be permitted to overstep.

It is suggested that the planning unit should be the Community of 1000 persons, enough to provide the quota of children for a nursery school. With multi-storey flats included the Community will be compact supporting its nursery school, a communal laundry, a communal restaurant and a crèche. Five of these Communities will form a Neighbourhood of 5000 persons with, say, a welfare clinic and schools. Eight Neighbourhoods will make up a Borough of 40,000 people, with secondary schools, a public park, swimming baths, a library and places of entertainment. In these areas it will be evidence of good planning that no child has to cross a dangerous traffic-way in order to get to school. Six Boroughs will compose a District of 240,000 people, who should have at their disposal every urban facility.

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[1] Page 382.

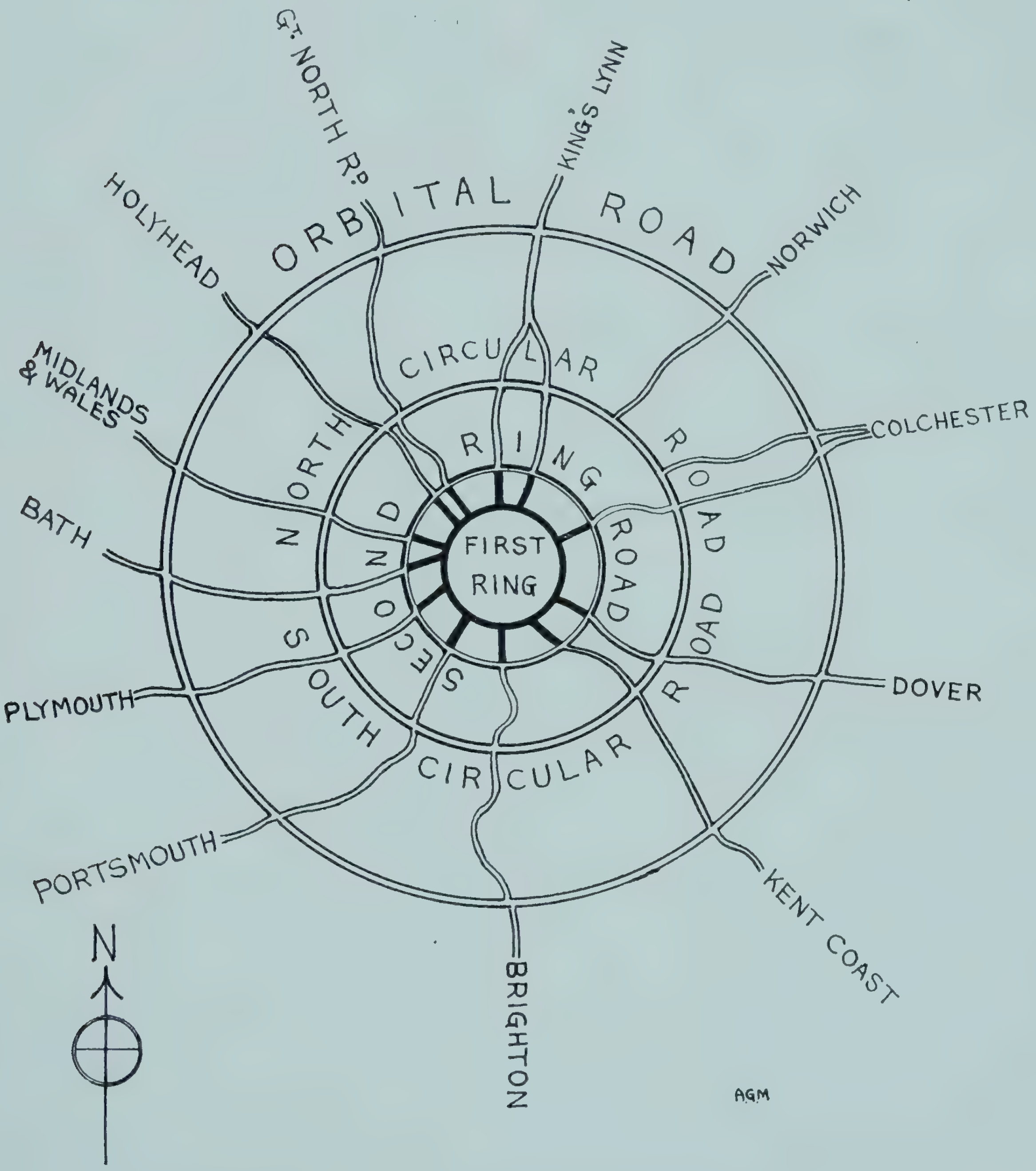
Gt. NORTH Rd.
KING'S LYNN
HOLYHEAD
ORBITAL ROAD
NORWICH
MIDLANDS & WALES
CIRCULAR ROAD
COLCHESTER
RING ROAD
BATH
NORTH
SECOND
FIRST RING
ROAD
PLYMOUTH
SOUTH
DOVER
CIRCULAR
PORTSMOUTH
KENT COAST
N
BRIGHTON
AGM

Fig. 94.—Plan for Greater London (Diagrammatic).

Among the numerous other problems which emerge in connection with the plan, either directly or by implication, are local decentralisation and hiving off, the location of industrial areas, the prevention of dormitory suburbs, the proportion of flats to self-contained houses, the siting of gas works and power stations, the worthier architectural treatment of lands fronting on the River, more convenient docks, the rearrangement of markets, the railway system and its terminals, the development of aerodrome and seaplane services, and the results of the obliteration of time-honoured boundaries.

Turning now to Post-War Country Planning, its major concerns are the security of agriculture, the lay-out of the arterial roads, and the preservation of the open prospect, incidental to the last of which is the settlement of villages as already noted. So it was arranged at the original planning of the great landed properties, which evolved the typical scenery of cultivated rural England, now admired by all. Recently these gracious landscapes, and others of their kind, have been scarred by ribbon development and inappropriate buildings of urban origin. Such invasions by the towns not only efface the charm of the country, they render disservice to agriculture. When bungalows are spread where crops should be, the sum total of the ploughland shrinks. With a view to checking this alienation of arable soil, planning authorities are empowered by the Town and Country Planning Act to declare an area to be a Temporary Agricultural Reservation, within which building is permitted only under prescribed conditions. The infiltration from towns, by youthful walking parties, into farm territory need not, and indeed should not, be closed down, but it can be regulated with the aid of roadways planned for the convenience of ramblers, including foot-paths specially made along field boundaries from which pedestrians in quest of the open-air life will not need to stray. Country planning may serve also to promote the development of afforestation, and picturesque ranges of crag and heather, woodland, or hill and dale, if threatened with disfigurement, can be designated National Parks and protected as such.

NEW TOWNS ACT, 1946

The purpose of this Act is to provide for the creation of new towns through the agency of corporations established and financed by the Government.

The Minister of Town and Country Planning, or in Scotland the Secretary of State, after consultation with the local authorities concerned, may make an order designating an area of land to be the site of a proposed new town. With a view to the development of such new town the Minister is required to establish a 'development corporation,' consisting of a chairman, deputy chairman and not more than seven other members. This body will have power to acquire, hold, manage and dispose of land, to carry out building and other operations, to provide water, electricity, gas, sewerage and other services, and generally to do anything necessary or expedient for the purposes of the new town. Subject to the consent of the Minister, the Act provides for the acquisition of land by a development corporation either by agreement or compulsory purchase. For public health uses, if the Minister of Health deems it proper, a united district may be constituted as under section 6 of the Public Health Act of 1936. Sewers or sewage disposal works vested in a sewerage authority may be transferred to the control of a development corporation. It is the duty of the Minister to give to any development corporation such directions with respect to the disposal of land as will secure the preservation of features of special architectural or historical interest.

When the Minister is satisfied that the purposes for which a development corporation was established have been substantially achieved, and when he is further satisfied, with the concurrence of the Treasury, that the circumstances are not such as to render it expedient on financial grounds to defer such action, he must proceed to the winding up and dissolution of the development corporation.

XVI.

HOSPITALS

THE number of beds thought necessary to be provided for all purposes in hospitals differs between one country and another and also locally within countries. The number rises where the general hospitals are freely used for all illnesses both slight and grave: it falls where they are reserved for serious cases only or for the destitute sick. It can be reduced without detriment where there is an outdoor medical service combined with domiciliary nursing. In the case of infectious diseases hospitals the number of beds rises where it is the endeavour to take in most cases of infection: it falls when the local authority is content to hospitalise the major infections only. In Australia lately the approved number of hospital beds for all purposes was 10 per thousand of population: in Canada it was 4·5 and in France 3. Among large English cities it ranged from 6 to 9.

In Great Britain on the average an adequate provision would be 5 beds for all purposes per thousand of population, of which 1 bed should be for infectious disease excluding smallpox and tuberculosis.

GENERAL HOSPITALS

Of the general hospitals of this country the most distinguished are the great voluntary institutions, which embody a high tradition and have a record of devoted service. General hospitals are maintained also by local authorities, providing treatment either under the title of public health or by way of the poor law. Waiting lists at voluntary hospitals are an expression alike of public confidence and of a shortage of beds. The proposed National Health Service will transfer voluntary hospitals to the ownership of the State. The Minister will entrust their administration to Hospital Management Committees under Regional Boards. In England and Wales teaching voluntary hospitals will have Boards of Governors of their own.

Points in the construction and arrangement of a well-equipped general hospital are noted below.

Site. In the United States, where the cost of land is fabulous and the winter cold severe, general hospitals have been erected in a vertical style, running up to many storeys on a narrow base. In this country it is usual to select a spacious site so that extremes of height are unnecessary. For large teaching hospitals the site should preferably abut on open land such as a public park.

Lay-Out. The administrative block should be central, with the boiler house, power house and similar services behind it, the whole being so planned as to admit of ready expansion. The ward units should be on either side of the administrative block. The nurses' and maids' homes should be in a separate building or buildings. The mortuary with chapel, the *post-mortem* room and the pathological laboratory should be accessible but not conspicuous, and should where possible be provided with a separate carriage way.

Out-Patient Block. In large hospitals this block should be self-contained with independent entrance. It includes a waiting-hall, lavatories, examination rooms, minor operating theatre, special departments, casualty room, dispensary and X-ray room. It should be connected by a covered way with the parent building.

Isolation Block. This block is for the treatment of venereal, skin and similar diseases in out-patients and in-patients, males and females separately. On the ground floor is the out-patient department with irrigation rooms and clinical laboratory. On the upper floor are wards for venereal and skin diseases.

Ward Units. Main wards should accommodate usually up to ten beds, and not more than sixteen. Their breadth should be 24 feet and the wall space per bed 8½ feet. In teaching hospitals the breadth should be 26 feet and the wall space 9 feet. If the beds are disposed, as in a few hospitals, parallel to the long sides the breadth of wards can be reduced to 20 feet. The height of ceilings should be 12 feet upwards. Single-bed wards should measure not less than 11 feet by 10. Two or three 4-bed wards should be provided. There should be a day room and sun balcony for patients, and a ward kitchen, ward-maid's pantry, linen room and store room for patients' clothes. The sanitary annexe should contain wash-hand basins, w.c., bath in bathroom, sink room with slop sink, steep sink, and bed-pan airing chamber, staff lavatory, and ventilated balcony for soiled-clothes receptacles. It should be placed at the entrance to the ward, opening directly off the access corridor without an intervening cross-ventilated passage. One wash-hand basin should be fitted in the ward itself.

Pay Wards. The wards for paying patients, either single- or multiple-bed, are best assembled in a pay-ward wing, and not distributed among ward units.

Operating Theatre. Each surgical unit should have its own operating theatre, with a floor area of 300 square feet and a ceiling height of 13 feet or over. The large end-window should look north. The top lighting will be electric. Tubular lighting has an increasing vogue for operative work and is suitable also for the theatre annexes. The electrical connections and equipment required for diathermy and similar specialised procedures should be installed. The air supply of the theatre should be conditioned. The anaesthetising room, sterilising room and robing room should adjoin the theatre.

Maternity Unit. This unit, if accommodated on the site, should be apart from the rest of the hospital and connected with it only by an open corridor. The unit should be equipped with at least 20 beds per 1000 cases of midwifery per annum in the district. The main wards should contain not more than eight beds, and 20 per cent. of the accommodation should consist of single-bed wards. The unit should include an examination room, four labour rooms which should be air-conditioned, and two nurseries, each affording 25 square feet per cot, one for the sick and one for the healthy infants: also babies' washing room, babies' bottle room and napkin laundry. The unit should possess, or have access to, an operating theatre and provision should be made for isolation. The ancillary rooms and sanitary annexe are as in other wards. A prenatal clinic should be associated with the maternity unit, and 3 prenatal beds should be provided for every 20 maternity beds. An isolation annexe of single bed wards for septic cases should adjoin the maternity unit but be separately staffed.

Radiology Block. The radiology block in a medium-sized hospital should include a radiographic and fluoroscopic room, measuring 20 by 16 by 11 feet high, with dark room and drying room for films adjoining, radiologist's room, admission office, and the necessary waiting-room and dressing cubicles. A large hospital should provide in addition a treatment room for superficial and deep therapy, with dark room and viewing room. Floors of X-ray rooms should preferably be of wood or else of battleship lincleum or rubber on concrete. Walls, floors and ceilings between X-ray and other rooms should be insulated with lead or barium slabs. Dark rooms and X-ray rooms should have air conditioning. Stores for records and films must be fire-proof. Motor generators, rotary converters and transformers should be housed in the basement or in a separate building. If the electrical treatment plant is located in the radiological block, it will be necessary to add ultra-violet irradiation rooms, together with rooms for Finsen light therapy and diathermy. Cables and flexes should be effectively insulated and should not be allowed to trail. The radiology block should be readily accessible from all parts of the hospital and should where necessary be provided with lifts for bed cases.

Physiotherapy Department. A gymnasium fully equipped with the apparatus necessary for remedial exercises and rehabilitation now finds a place in the modern hospital. Foam and other special baths and specialised electrical equipment may be installed. The facilities of the department should include dressing rooms, spray rooms, bath cubicles and offices. The unit should be staffed only by trained personnel.

Administrative Block. This block may contain an entrance hall, porter's box, public office, waiting-room, superintendent's, matron's and house steward's offices, board room, quarters for matron and resident medical officers, kitchen and stores. One general kitchen should suffice for patients and all grades of the staff. Nurses' and maids' dining rooms should adjoin the kitchen with serveries between.

Kitchen. The kitchen itself should be large and airy and preferably tiled. Tables and benches should be enamel topped or finished in monel metal, and cupboards should be well-lit. The principal annexes are a larder, refrigerator, ice cream freezer, vegetable store, food preparing room and servery counter. The cooking apparatus should include ranges with hot plate-racks, jacketed boiling pans, milk heaters, roasting and baking ovens and steaming pans. Automatic tea infusers, bread slicers, power potato peelers and dish washing machines exemplify modern developments in hospital kitchen equipment. A subsidiary dietetic kitchen should be provided in large general hospitals.

Nurses' and Maids' Homes. In large hospitals these are separate, in small hospitals combined. They should include a recreation room with a piano and table tennis facilities, writing rooms and visitors' room, and may or may not include sick rooms and a small hand laundry. A study room with charts and a selection of suitable text books is appreciated. Every nurse and maid should have a centrally heated bedroom to herself, with a floor area of 100 square feet or more. The lavatories should be equipped on the basis of one bath to 6, and one w.c. to 6. Electric hair driers may with advantage be installed. There should be a fixed wash-hand basin with hot and cold water in each bedroom. Suitable incinerators should be provided. Quarters for the night staff should be free from noise during their hours of sleep. In large hospitals the training school for nurses may be located in this block.

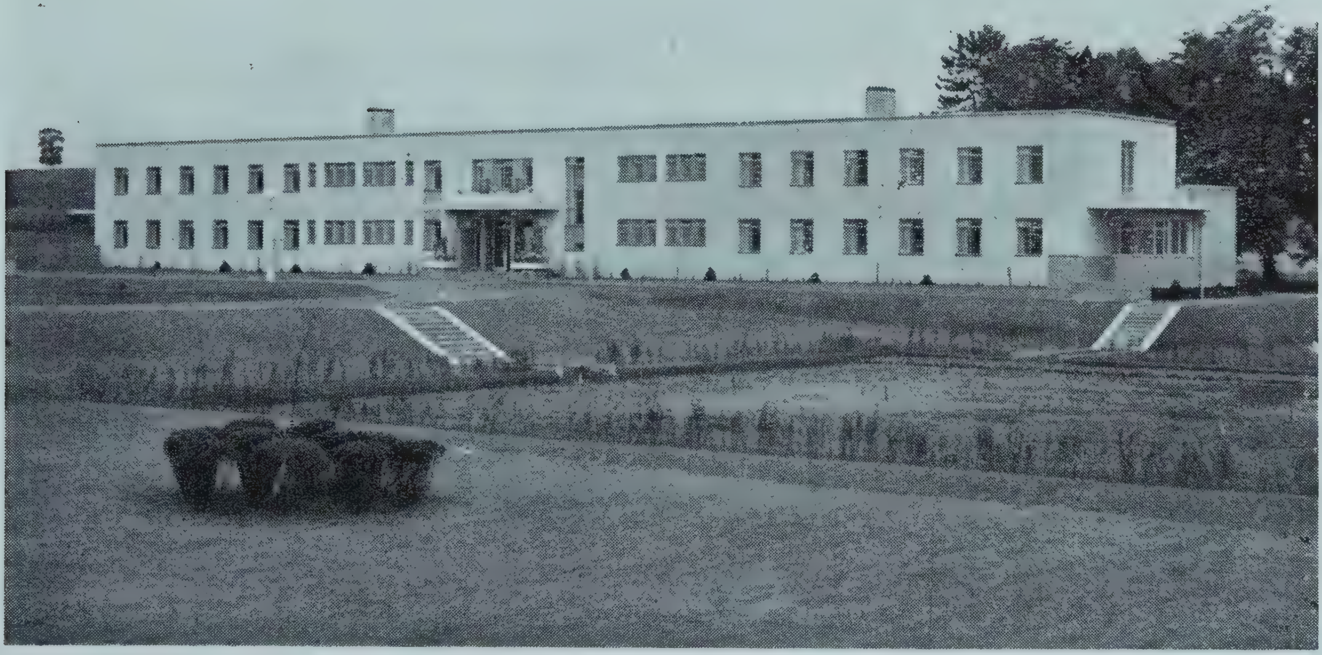

Fig. 95.—Nurses' Home.

Structure and Details. Ward blocks should be built of stone or brick, or brick coated with cement mortar. Floors of wards should be of pitch pine or maple in 3-inch widths, laid on wood joists resting on fire-resisting reinforced concrete, or of ordinary white pine covered with thick linoleum. Floors of sanitary annexes should be of terrazzo: floors of operating theatres of terrazzo laid in panels. Floors of corridors may be of wood, or preferably cement, with a central rubber or linoleum runner. Terrazzo laid in panels makes a good flooring for corridors also. The walls of wards should be of Portland cement, finished in Keene's cement up to 5 feet and plastered above, the whole thereafter painted and enamelled. Walls of operating theatres should be of tiles or terrazzo. Walls of sanitary annexes should be finished in cement to full height and then painted and enamelled, or tiles may be used. Windows of wards should have an area of 1 square foot for every 5 or 6 square feet of floor. The best type is the double-hung wooden or metal sash window with hopper above the transom and hinged sill board. Doors of wards should be 4 feet wide to allow the passage of a bed. Swing doors are the best for all wards and corridors.

Warming should be on the central heating system by low-pressure hot-water radiators, fed from calorifiers either in the power house or in the various blocks or on the several floors. Ward temperature should be 60-65° F. Operating theatre temperatures should be rather higher. Each main ward should have an open fire also, for the sake of its pleasant warming rays and assistance to ventilation. Domestic hot water, which should be distinct from the general heating system, should be delivered from the taps at 120° F. The kitchen, which requires hotter water, should have a separate service.

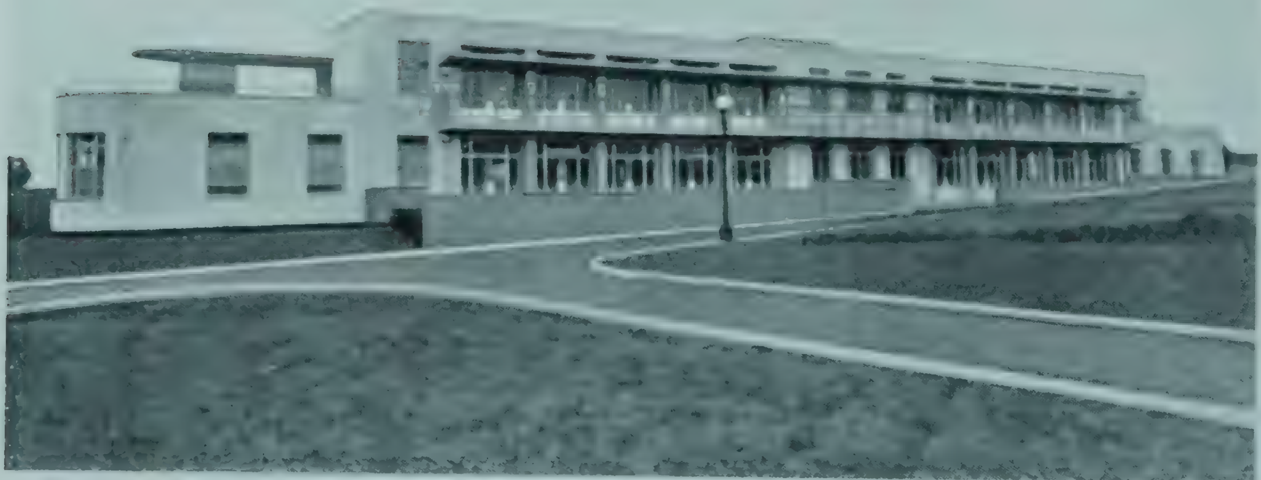

Fig. 96.—Cubicle Isolation Block.

Ventilation. Excepting operating theatres, labour rooms, dark room and X-ray rooms, to which reference has been made, the whole hospital should be served by natural ventilation. The wards, with opening windows on opposite sides, offer every facility for cross-ventilation. Air may be admitted also by means of window-breast inlets guarded by radiators to warm the entering air in cold weather.

Lighting. Artificial lighting should, where possible, be by electricity. Lamps hung from ward ceilings should have deep opaque shades so as not to shine in the patients' faces, or else diffused lighting may be employed. Blue- or green-tinted lamps either suspended from the roof, or as panel wall lights, should be provided for use at night. There should be a shaded lamp at the head of each bed, together with wireless ear-phones. Wall plugs should be provided between beds for portable lamps, and each ward should have an adequate number of power plugs to enable X-ray films to be taken of patients in bed, and for electrical treatment.

Disinfector. An apparatus for disinfecting bedding and disinfesting the clothing of patients will be found of service.[1] It should adjoin the wash house and be managed by the hospital engineer or his deputy, as at a disinfecting station.

Staff. The Committee on Nursing Staff of King Edward's Hospital Fund for London have recently proposed a standard of staffing for general hospitals undertaking work with acute cases. The suggested standard is 70 nurses per 100 in-patient beds, this number to include 5 sisters, 5 staff nurses, 10 fourth year student nurses and 50 first to third year student nurses. It is further suggested that, on the block system of training, in which there is a periodic withdrawal from the wards of all student nurses for theoretical instruction, the number of first to third year nurses should be increased by one fifth, making a total of 80 nurses per 100 in-patient beds. It may be necessary to modify these standards in terms of accommodation, domestic staff available, hours of duty and other factors. While fully realising the difficulties of the present time, the Committee feel that the standards suggested should be aimed at. The appointment of 'ward orderlies' may, it is hoped, assist in bridging the gap between present needs and the future supply of fully trained personnel.

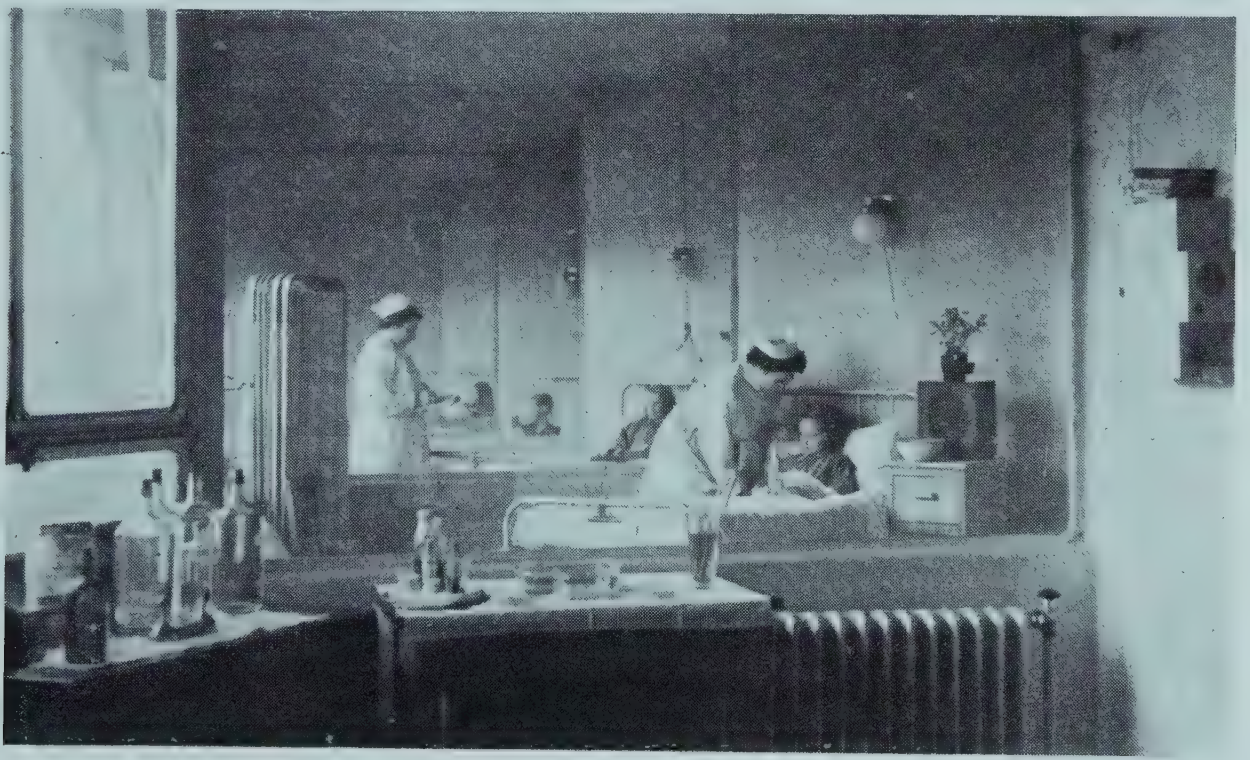

Fig. 97.—Isolation cubicles in series.

ISOLATION HOSPITALS

Smallpox and tuberculosis excluded, the total isolation beds in an area should be on an average, as already stated, in the proportion of 1 to 1000 of population. For industrial towns 1 to 750 is suitable. For country districts 1 to 1500 may suffice. Owing to the facility of motor transport by road, isolation beds can now be concentrated in good-sized hospitals serving extensive areas. The removal even of pneumonia cases can be effected over considerable distances as late as the fourth day of illness without grave risk.

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[1] Page 431.

The site of an isolation hospital should allow 1 acre per 20 beds and should at the same time have ample room for expansion or permanent enlargement. The whole site should be enclosed by a wall at least 6 feet 6 inches high. The enquiry and interview room should be at the porter's lodge. The administrative block, which should lend itself to extension, should be centrally placed. In large isolation hospitals the nurses and maids should be quartered in a separate home. The minimum number of nurses may be put at 1 to 3 patient beds: the number of maids at 1 to 8.

The pavilions containing the wards should be at least 40 feet from one another and the boundary wall. They may be of one or two storeys, and their long axis should run from a little east of north to a little west of south. A main ward may contain up to 20 beds. Its breadth should be 24 feet and the wall space per bed 12 feet, that is to say, with 12 feet between bed centres. Steam jets with pressure-reducing valves should be made available for the treatment of laryngeal diphtheria. A glass-roofed verandah 10 feet wide may run along the south wall of a pavilion, having outlets for warm air where the glass roof meets the wall. French windows 4 feet wide opening from the wards on to the verandah permit of beds being wheeled out.

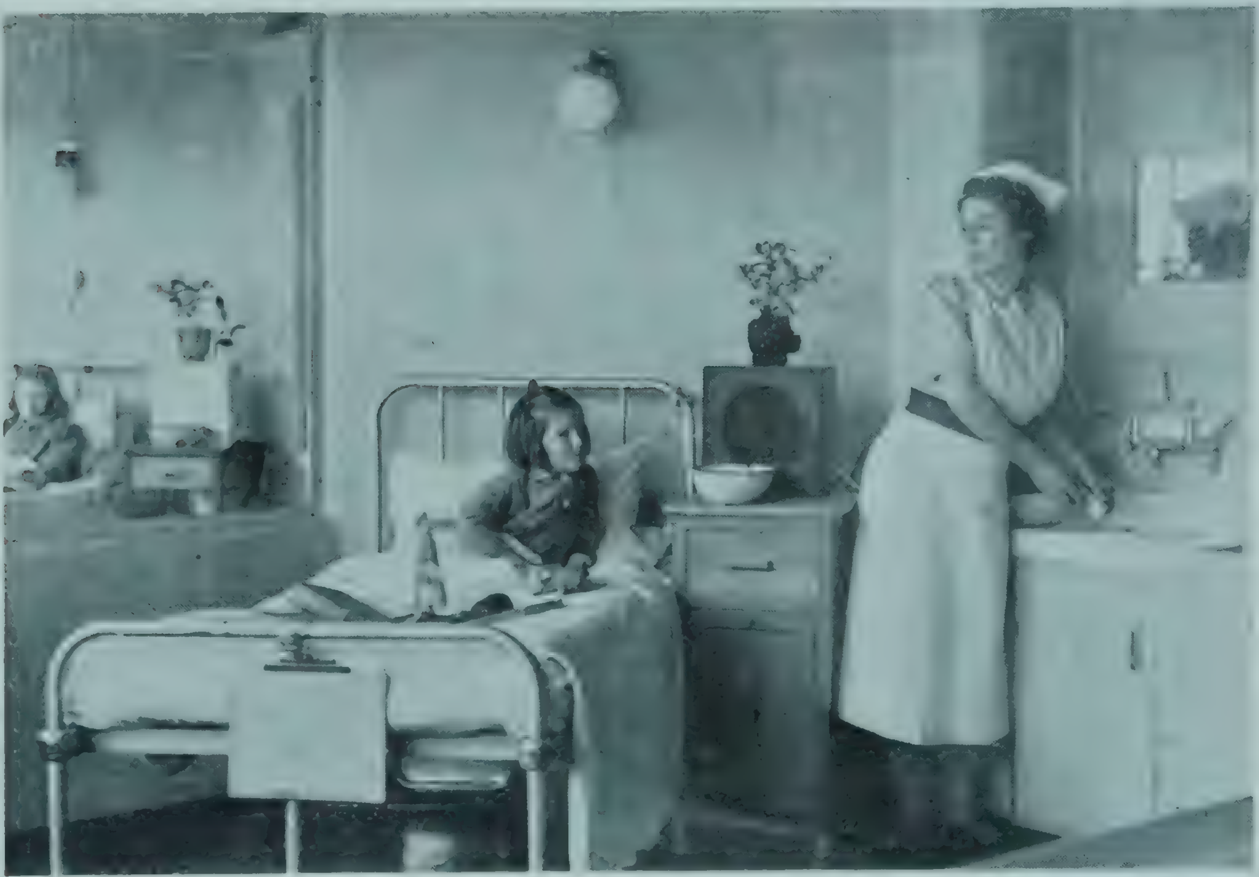

Fig. 98.—Detail of isolation cubicle, including individual wash-hand basin with elbow-control tap.

Isolation beds should be provided, some in side rooms of pavilions, others in a special block (Fig. 96), made up of a series of one-bed cubicles or cells (Fig 97), separated from one another by plate-glass partitions, so that the occupants of the cubicles, though in aerial isolation, are all under the nurse's eye from the centrally situated duty room.

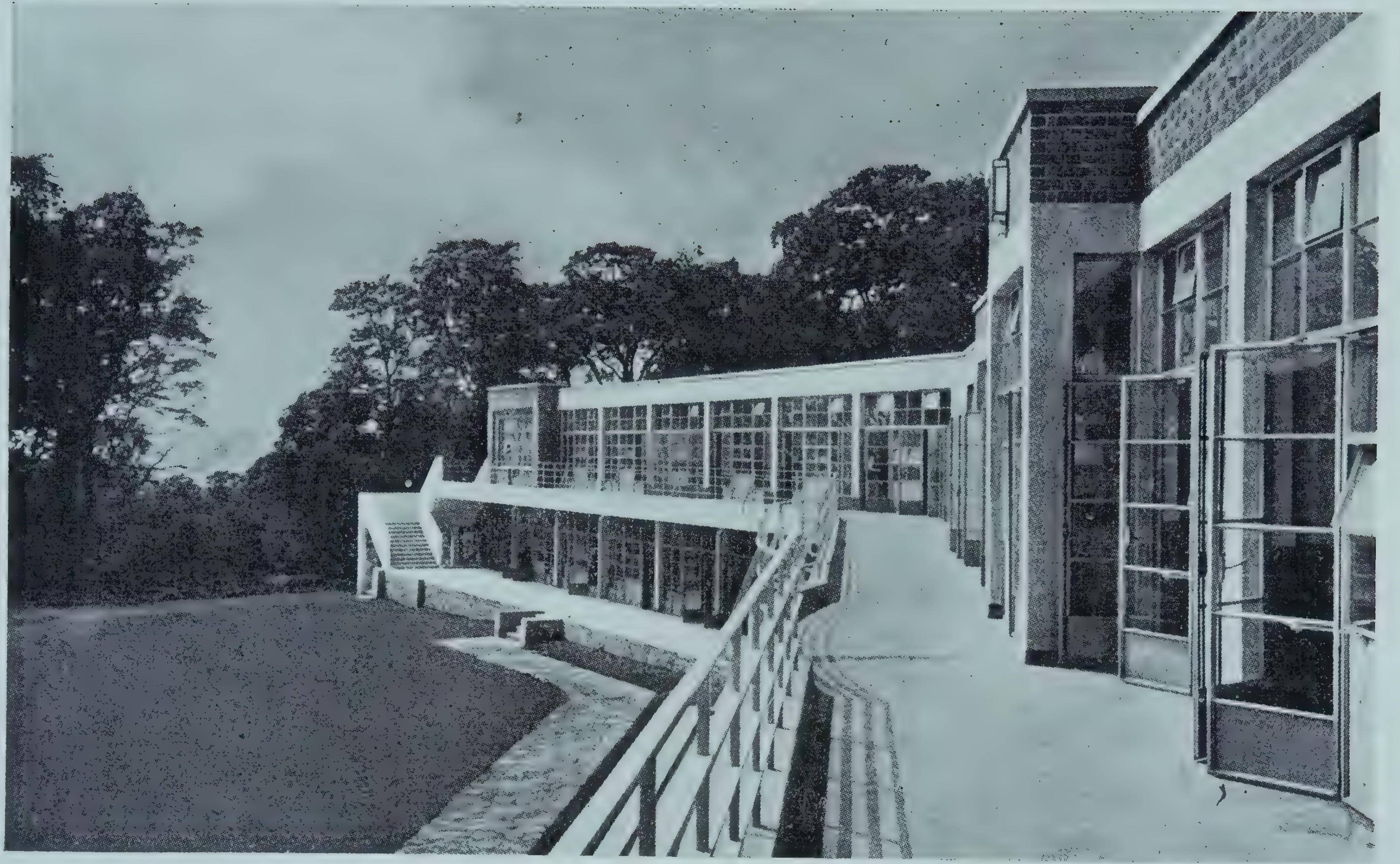

Fig. 99.—Modern Sanatorium.

Each cubicle should enclose a wash-hand basin (Fig. 98) *plus* high swan-neck tap for filling jugs. In order to prevent the transmission of infection from cubicle to cubicle by door handles, the provision of swing doors furnished with metal kick plates should be the rule.

The materials used for the building of isolation hospitals should be the same as for general hospitals. If wards require to be erected in haste to meet an unforeseen emergency lighter material such as wood or iron may be used. In times of epidemic prevalence, tents may be employed as a temporary measure. The regulation military hospital marquee is adequate for 3 patients.

A pressure steam disinfector is essential and a formalin disinfector should be installed also. Rooms adjacent to the disinfector premises may conveniently be provided with running water and baths for the cleansing of verminous persons and the treatment of scabies. In small towns the steam disinfector at the isolation hospital should also serve the purposes of the local health department.

A smallpox hospital must not be within a quarter of a mile of a population of 200 persons, or within half a mile of a population of 600 persons, and should not be used at one and the same time for the reception of cases of smallpox and of persons suffering from other diseases.

SANATORIA

The provision of beds by a local authority for persons suffering from tuberculosis should be at the rate of one bed per annual death from tuberculosis in the area. Of the total beds 75 per cent. should be for pulmonary tuberculosis and the balance for other forms. Where a separate sanatorium and tuberculosis hospital are provided, the beds for pulmonary tuberculosis should be equally shared between the two institutions. Alike on disciplinary and other grounds the separate plan, wherever possible, is to be preferred. It is however becoming more usual to provide a single institution which functions as a combined sanatorium-hospital, containing all the pulmonary tuberculosis beds for the area. The beds for the 'sanatorium' cases should be in large dormitory wards: those for the 'hospital' cases in cubicles and small wards. Chalets which can be rotated so that they continually face the sun may be provided, but should not account for more than a small proportion of the bed accommodation. The staff normally required would be one nurse to 4 patient beds and ward-maids in the same proportion. The site of the institution should allow at least one-fifth of an acre per patient. Ward arrangements resemble those of general hospitals. One bath to 10 patients and one wash-hand basin to 6 patients are a sufficient allowance. There should be a central dining room for ambulant cases. Each unit should possess a sputum sterilising autoclave. There should be an operating theatre and radiology and light therapy units should be provided.

Most modern sanatoria (Fig. 99) include occupational therapy departments and workshops for the rehabilitation of patients. Amongst indoor trades which patients may learn are basket-making, book-binding, cabinetmaking, cobbling, upholstery, wireless repairing and the like. Outdoor occupations are represented by carpentry, market gardening and motor mechanics.

MENTAL HOSPITALS

Mental hospitals should accommodate not more than 1,000 patients and should be planned on the villa system on a site of at least 150 acres. Special arrangements are required for restless patients, for the sick and senile cases, for those able to work and for infectious cases including tuberculosis. Occupational therapy workshops should be provided. Other details are as for general hospitals.

NURSING HOMES

Under the Public Health Act, 1936, any person carrying on a nursing home is required to be registered by the council of the county or county borough in which the home is situated. Registration may be refused on the ground of the age or other unfitness of the applicant or for reasons connected with the state of repair of the premises or the staffing or equipment. In a nursing home other than a maternity home the person in charge must be either a registered medical practitioner or a registered general nurse resident in the home. In a maternity home the nursing of the patients must be under the superintendence of either a registered general nurse or a certified midwife. The local authority may make byelaws as to the keeping of records of the patients and, in a maternity home, of records of miscarriages and children born in the home. Nursing homes are subject to inspection by the medical officer of health or other authorised person. Government and local authority hospitals, mental hospitals and certified institutions under the Mental Deficiency Acts, are not accounted nursing homes.

NURSES

In England and Wales it is the law that nurses for the sick must be registered in the register kept by the General Nursing Council. A later statute brought into being the grade of 'assistant nurses,' who require to be enrolled in the 'Assistant Nurses Roll.' The same statute restricts the use of the title 'nurse' to registered nurses and assistant nurses who have been duly enrolled. This prohibition does not apply to children's nurses, and it is permitted by regulation that certain other persons, otherwise under prohibition, may use as a title any expression including the word 'nurse' in such a manner as to distinguish them from registered nurses and enrolled assistant nurses. Persons carrying on an agency for the supply of nurses for the sick must be authorised by licence, and may only supply the grades of nurses specified by regulation.

The position in detail is noted hereunder.

Nurses Registration Act, 1919. This Act provides for the registration of nurses for the sick in England and Wales. The Register of Nurses, which is kept by the General Nursing Council, consists of the following parts: (1) General Nurses, (2) Male Nurses, (3) Mental Nurses, (4) Children's Nurses and (5) any other prescribed part. A part of the register has been prescribed for Fever Nurses. The General Nursing Council lays down the rules for the certification of nurses and for the conduct of their examinations, and deals also with their removal from, and restoration to, the register.

Nurses Act, 1943. This Act introduces the new grade of 'assistant nurses' of whom the General Nursing Council is to form and keep a Roll. The council will also make rules as to the training, experience and examination tests which will qualify for enrolment. An Assistant Nurses Committee will be composed of members of the council together with representatives of the assistant nurses. To this committee any matter wholly or mainly concerning assistant nurses is to stand referred. There is to be kept by the General Nursing Council, in terms of section 18 of the Act, a List of persons (not being registered nurses or enrolled assistant nurses) who, having applied for admission to the list, are found by the council to hold certificates showing that they had completed a course of training in nursing before a date in 1925, and who satisfy the council that they are of good character and are possessed of adequate knowledge and experience. The Act also lays down that, as from a date ordered by the Minister, any person (not being a duly registered nurse under the Act of 1919 or a duly enrolled assistant nurse) who takes or uses the name or title of 'nurse' will be liable to a fine on conviction. Children's nurses, however, may without offence continue to call themselves nurses.

Nurses Regulations, 1945. These regulations authorise the use of specific names or titles containing the word 'nurse' by certain classes of persons notwithstanding that they are neither registered nurses nor enrolled assistant nurses. These classes and their authorised designations are as follows:

Persons under 21 who have passed for the general part of the Nurses Register, but cannot on the ground of age be admitted to registration, may use the name or title of 'trained nurse.'

Persons under 21 who have passed for another part of the Nurses Register, but cannot on the ground of age be admitted to registration, may use any expression containing the words 'trained nurse' which sufficiently indicates what part they are in.

Persons in the general part of the General Nursing Council's section 18 list referred to above may use the name or title of 'trained nurse.'

Persons for the time being in some other part of the section 18 list may use any expression containing the words 'trained nurse' which sufficiently indicates what part they are in.

Persons certified under Midwives Acts or certain other sanctions may use the name or title of 'maternity nurse.'

Persons undergoing training for admission to the Nurses Register may use the name or title of 'student nurse.'

Persons undergoing training for admission to the assistant nurses Roll may use the name or title of 'pupil assistant nurse.'

Certain persons employed in mental nursing, or certified by the Tuberculosis Association, or holding the orthopaedic nursing certificate of the Central Council for the Care of Cripples, or trained in foreign places and listed by the Minister of Health as having completed training, or recognised by the Church of Christ Scientist, may use any expression containing the word 'nurse' which sufficiently indicates what he or she specialises in.

A person serving in the Army or Air Force and qualified therein as a trained nurse may use the name or title of 'trained nurse.'

A person entitled as above to use the name or title of trained nurse, or passed in the Navy as leading sick berth attendant may, when no longer serving in the Navy or Army or Air Force, use the name or title of 'service-trained male nurse.'

Nurses (No. 2) Regulations, 1945. Under these Regulations persons of the age of 18 or over who are acquiring experience in nursing under the supervision of trained nursing staff in a hospital or institution, with a view to enrolment as assistant nurses, may use the name or title of 'probationer assistant nurse.'

Nurses Agencies. The Nurses Act, 1943, also has it that a person carrying on an agency for the provision of nurses may supply only registered nurses, enrolled assistant nurses, certified midwives or other classes of attendant as may be prescribed. The person must keep records of the work of the agency, and must hold a licence from the appropriate licensing body to carry on in the specified premises. It is the duty of the licensing authority to enforce the provisions of the Act. Any registered nurse or other officer authorised by the licensing authority may at all reasonable times enter and inspect any premises used or believed to be used or in connection with the supply of nurses. The Nurses Agencies Regulations, 1945, prescribe a comprehensive form of application for licence. They also sanction the supply by agencies of persons in the section 18 list of the Nurses Act, 1943, together with certain other persons employed in mental nursing, or certified by the Tuberculosis Association, or holding the orthopaedic nursing certificate of the Central Council for the Care of Cripples, or entitled to use the name or title of 'service-trained male nurse.'

Nurses in Scotland. The arrangements dealing with nurses in Scotland and those cited above for England, though independent of one another, are on the same pattern. The Scottish Acts and Regulations are:

The Nurses Registration (Scotland) Act, 1919.
The Nurses (Scotland) Act, 1943.
The Nurses (Scotland) Regulations, 1945.
The Nurses (Scotland) (No. 2) Regulations, 1945.
The Nurses Agencies (Scotland) Regulations, 1945.

They differ from their English opposite number in their national title. In their substance they are the same, and may be so read.

The English Act of 1943 enables assistant nurses enrolled in Scotland to obtain admission to the English roll. The Scottish Act of the same year makes corresponding provision for admitting to the Scottish roll assistant nurses enrolled in England.

The status of the nursing profession was notably elevated pursuant to recommendations, made for England by Lord Rushcliffe's Committee and for Scotland by Professor Taylor's Committee, with a view to improving the working conditions of nurses and increasing their emoluments. New national scales were accordingly introduced for both countries, taking effect as from 1st April, 1943, and applying not only to hospital nurses but also to health visitors, domiciliary midwives, school and district nurses, assistant nurses and other groups.

The vital importance to a community of an adequate nursing service was made very clear by the nation-wide shortage of hospital staffs revealed upon the close of the Second World War. All types of hospital were gravely affected but the hardest hit were sanatoria, mental hospitals and institutions for the aged and infirm. The official paper of 1945 entitled 'Staffing the Hospitals' recounts the measures adopted to attract suitable persons to hospital work and looks forward to further progress.

The paper tells how men and women who leave the Armed Forces or other National Service are encouraged to take up hospital duty, special allowances being given to those who undergo nursing training. Encouragement is extended also to pre-nursing courses between school-age and the age of entry into nursing schools. To maintain and raise the standards of teaching, Government grants are made to selected nurses who wish to qualify as Sister Tutors. The release by stages from the Civil Nursing Reserve will enable those released, if found suitable, to enter the courses of training for state registered nurses or assistant nurses. The acceleration of general mobilisation will free from the services more men and women with training in nursing, catering or domestic work, all of whom can be turned to account for hospital purposes. Nurses released from the Forces have been urged to resume civilian nursing. Releases from the Women's Auxiliary Services are providing women who can volunteer, some to train as nurses, others to engage as hospital cooks.

Turning now to 'further progress' in the near or middle future the paper refers to the formation of a new National Reserve of Nurses. It suggests the increased use of male nurses, the greater employment of married women as nurses, and also the wide establishment of 'ward orderlies,' that is to say, men and women who will act as direct auxiliaries to the nursing staff.

The salaries of nurses, already raised, should, it is recommended, be further increased.

The domestic and other workers in hospitals receive an appreciative notice. 'The importance of their work cannot be over-emphasised.'

The need for carrying out the recommendations of the Rushcliffe and Taylor Committees has been plainly underlined by the recently published report of the Working Party on the Training and Recruitment of Nurses. It was found by this Party that of every hundred student nurses, often fewer than 50 complete their training. The main reasons for default, as furnished by questionnaire, are dislike of irksome hospital discipline, length of working hours, monotony of diet, inferiority of quarters, distaste for domestic duties and lack of recreational facilities.

Among recommendations made with a view to encouraging recruitment, are full student status for nurses in training, the abolition of domestic tasks for student nurses, a 40-hour working week and an annual holiday of six weeks. The suggestions are also made that there should be central training units, administered by the appropriate Regional Hospital Boards, and that student nurses should be under the control of the training authority rather than that of the hospitals.

In so far as promotion is concerned, it is considered that higher posts in the nursing profession should be awarded only to those who show a right understanding of human relationships.

The Working Party likewise point out that in order effectively to introduce the necessary 3-shift system in Britain, it will be essential to maintain an annual strength of 22,000 trained nurses and 14,000 nursing orderlies. Allowing that present wastage is checked, these numbers could, they say, be reached in approximately five years.

The proposed conditions of hospital service are set forth in two Appendices, the first for Hospital Nurses and Midwives and the second for the Domestic Staff. To reproduce the Appendices here would be long. Suffice it to say that they are reasonably framed, and to list their headings.

I. *Hospital Nurses and Midwives.* Training, Salaries, Superannuation, Hours of Duty, Off-duty, Holidays, Health, Food, Accommodation, Nurses' Representative Councils, Discipline, Representation, Recreation and Social Life, Equipment, Domestic work, Living out, Married Nurses, Part-time Nurses.

II. *Hospital Domestic Staffs.* General Conditions, Wages, Hours of Work, Off-duty, Holidays, Health, Food, Accommodation, Staff Committees, Discipline, Representation, Recreation and Social Life, Personnel Management, Methods of Work, Labour-Saving Devices, Training and Promotion Prospects, Juvenile Workers, Uniform.

It may be added that the national organisation for improved conditions of the domestic and kindred workers in hospitals developed from the recommendation, in 1943, of certain wage and other standards by Sir Hector Hetherington's Committee.

ALMONERS

Modern developments in preventive medicine have greatly increased the need for experienced medico-social workers, and have in addition widened the scope of their activities. Candidates for the profession of almoner are selected by the Institute of Almoners. The two to three year course of training includes lectures in psychology, social economics, industrial history and social administration, together with practical instruction in family case-taking, visiting and investigating, and office routine. Eleven of the fifteen months of field work are spent in acquiring a first-hand knowledge of the duties of almoners in hospital. Following the theoretical part of the course, successful candidates are awarded the Certificate or Diploma in Social Study. At the end of the practical training they are admitted as Associates of the Institute.

The work of the hospital almoner includes investigation of the social and psychological background of individual patients: co-operation with hospital medical staff to ensure that prescribed treatment is being followed: after-care of patients discharged from hospital: activities connected with the resettlement and rehabilitation of the disabled: the provision of comforts and medical appliances for those transferred to their homes for treatment, or as incurable. Other duties are the teaching of student almoners, and lectures to medical and nursing staffs on the rôle of social work in sickness and disability. Almoners may also share in the framing of hospital policy in so far as it concerns the welfare of patients; they play an increasingly important part in the collection of the social data so necessary for the organisation and interpretation of morbidity surveys; and their value as liaison officers between hospital, patient, industry and the Ministry of Labour and National Service can scarcely be over-stated.

While almoners are in general encouraged to choose a wide zone of operation, there are nevertheless instances where specialisation later is advisable. In the tuberculosis scheme, for example, much good may accrue from the almoner in her capacity as social visitor, especially to those patients who are readjusting themselves in employment after discharge from a sanatorium. There is work for the almoner in the maternal and infant welfare services, and in the venereal diseases administration, particularly with regard to adolescent girls who, cast out from their homes on account of recurrent misbehaviour, are on the brink of a career of profligacy. A place is now being found for the almoner in the field of mental health and much interest is being taken in the qualifying course in psychiatric-social work, the aim of which is to fight the problems of juvenile and adolescent delinquency, the battle ground being the home, the school and the child guidance clinic.

The applications of the almoner service have steadily increased since, some fifty years ago, the first almoner was appointed at the Royal Free Hospital in London. As the national health scheme develops, it is hoped that the duties of the almoner may be even further extended to include the social aspects of general medical practice, as well as those problems brought to light by the operation of the health centres. The indication from present trends is that the almoner has an increasingly important part to play in medico-social administration.

XVII.

INFECTION

The infectious diseases of man are transmitted from their infective source either as the result of direct contact or propinquity or through a variety of intermediary agencies, animate and inanimate. They are each due to a bacterium, protozoon or filter-passing virus, which becomes parasitic in the body of the host. A long-continuing infective state of the host favours the spread of the microbe: a disease which quickly kills the host usually cuts off the microbe too. The ideal parasitism is one in which the parasitic micro-organism thrives and proliferates undisturbed, while the host suffers no apparent damage. At present it is most nearly attained in man during the course of latent amoebic dysentery or in the carrier condition as seen in cerebrospinal fever.

BACTERIAL INFECTION

In some bacterial diseases the infective organisms remain localised in a part of the body: in others they are distributed in the lymph or blood stream. In either case their ill effects on the tissues of their host are mainly produced through the agency of toxins, including exo- and endo-toxins, the former of which may possess antigenic properties.

Exotoxins are extra-bacterial, freed during the life of the bacterium. Not many bacteria form exotoxins: the best-known examples are the bacilli of diphtheria, tetanus and botulism, all of which produce specific exotoxins affecting the nervous system. Exotoxins derived from diphtheria bacilli cultivated *in vitro* are used as a test of immunity in the Schick test, and as an antigen to produce in the blood of horses diphtheria antitoxin for the treatment of that disease. Exotoxins are liberated also by *B. dysenteriae* (Shiga) and some pyogenic cocci.

Endotoxins are intra-bacterial. They belong to the protoplasm of the bacterium and are mainly liberated when the microbe dies and undergoes disintegration. Endotoxin effects are produced by *B. tuberculosis, B. typhosus* and many other bacteria. They are non-specific, being the general changes common to most bacterial invasions, such for example as pyrexia, cloudy swelling, suppuration and necrosis.

Incubation

In bacterial infections an interval of time elapses between the invasion and the actual onset of symptoms. This stage of latency is the incubation period, during which the infective agent is gathering strength. While the incubation lasts a person is not usually infective, but the bacteria are multiplying in his body, elaborating toxic substances and producing other effects. The incubation period is subject to variation. It is affected by the dimensions of the original infective charge as well as by the degree of susceptibility of the host. For each disease it tends to have a fairly constant average duration between rather wide limits. Some accepted incubation periods are listed elsewhere.[1]

Carrier State

During an attack of infectious disease the pathogen is present in the body of the sick person, as can often be demonstrated at some stage of his illness. In a number of infections, however, this period of pathogenic activity is but one phase in the life history of the micro-organism, which is able also to sustain its existence in or upon the body of man as a non-pathogenic parasite.

Carriers are the healthy hosts of a facultative pathogen. They are known to exist in relation to such diseases as diphtheria, typhoid fever, cerebrospinal fever, bacillary dysentery, cholera and the respiratory infections. They doubtless exist, although undemonstrated, in other bacterial infections also. The carrier state may supervene upon an attack of infectious disease, such carriers being grouped as convalescent, chronic or permanent according to duration. It may occur also in persons who have never had the disease. They may have been contacts with a case, and have come under notice on that account. Often however their condition cannot be so explained. During outbreaks of cerebrospinal fever the free carriers may outnumber the cases many times over. They are not, it seems, a side objective for the meningococcus, but its main line of advance, which has for both host and parasite a good survival value.

Carriers may be sources of risk to the people among whom they dwell, for the germs which they harbour, though innocuous to themselves, may assume pathogenic characters and produce serious or fatal illness when transferred to another host. It is not however always so. Pilgrims returning from Mecca to El Tor, for example, were found to include a substantial number of cholera vibrio carriers, though clinical cholera had not appeared among them throughout their visit to Arabia. This suggests that under certain conditions the carrier may be blameless. Again, when diphtheria was epidemic in a residential school it was shown by S. F. Dudley that the number of carriers may go up as the epidemic declines and may continue to rise after it is over. This suggests that under other conditions the carrier may be not merely blameless but even useful.

PROTOZOAN INFECTION

The phenomena of protozoan infection are in many respects like those due to bacterial invasion. The pathological changes which occur may be produced both in the vicinity of the protozoon and remotely. Exotoxins have not been demonstrated in the case of the pathogenic protozoa, though many effects to which they give rise suggest the action of endotoxins. In some cases the foreign proteins of the parasites may function as antigens. A carrier condition is not infrequent in infections by protozoa. *Entamoeba histolytica* may remain latent in the intestine between the acute attacks of dysentery. A feature of latent protozoon infections is that the host often exhibits immunity to re-inoculation.

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[1] Page 424.

Virus Infection

In a number of communicable diseases, including some of the most prevalent, the specific organism is a living entity so small or plastic that it can traverse a porcelain or other filter. Among diseases which have been ascribed to these filter-passing viruses, which vary in size from 12 to 270 micro μ,[1] are smallpox, chicken pox, hydrophobia, measles, mumps, poliomyelitis, encephalitis lethargica, herpes, yellow fever, influenza, infective coryza, foot and mouth disease, trachoma, psittacosis and glandular fever. Most of the viruses are beyond the range of direct microscopic vision. Developments in the manufacture of quartz lenses and in the technique of short-wave ultra-violet illumination have however brought a few of the larger varieties under direct observation. The introduction of the electron microscope, which employs the cathode ray instead of light, and is fitted with electro-magnets in place of lenses, has made resolution down to 5 micro μ possible and thus enables most of the smaller viruses to be photographed. Several viruses have been grown in vitro by tissue culture and some have been cultivated in the chorio-allantoic membrane of fertile hens' eggs. Such are those of influenza, vaccinia, typhus and yellow fever.

Source of Infection

The source of infection is usually a previous case or carrier, either human or animal. The previous case may set the infective organism free in a natural discharge or evacuation. Thus the faeces of man are the medium of exit in typhoid fever and cholera, the urine in typhoid fever, the saliva in mumps, the sputum in pulmonary tuberculosis and pneumonic plague, and the nasopharyngeal or faucial secretions in cerebrospinal fever, poliomyelitis, measles and diphtheria. Pathological discharges may be the vehicle in scarlet fever, septic infections and venereal disease, and detached crusts in smallpox and chicken pox. Abortive, missed and unrecognised cases are prolific sources of infection. When a protozoon, as in malaria, is imprisoned in the circulating blood it may find egress through a percutaneous wound made by a blood-sucking insect. Carriers, like cases, are transmitters of the germs which they harbour. In anthrax, glanders, hydrophobia, and frequently also in plague and tuberculosis, the previous case is an animal. In African sleeping sickness the antelope and other game may serve as standing reservoirs of the specific micro-organism, by means of which an endemic prevalence of the disease can be maintained or fresh epidemics started. Infection may originate also from an inanimate source, such as the soil, in which the specific germ is saprophytic. Tetanus, botulism and gas gangrene are examples of this type.

Path of Infection

Infection may pass from person to person by direct contact of surfaces as in venereal disease. It may be derived indirectly from a remote origin through drinking polluted water. Water is the vehicle of election for cholera, and a principal agent in disseminating typhoid fever. Milk may take up infection either before withdrawal as in tuberculosis, or after withdrawal as in scarlet fever, and in either event may produce disease in the consumer. Under a competent system of meat inspection, meat is an unlikely path for the tubercle bacillus, but preserved or prepared meats may on occasion give rise to bacterial food poisoning. Fish which feed in polluted estuaries and also uncooked shellfish and vegetables may convey typhoid fever. Materials such as clothing, blankets and bedding, articles such as pencils and spoons, and also cups by way of dish water in canteens, may serve from time to time as infective agents.

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[1] 1 micro $\mu = \cdot 001\,\mu$.

Often the transference to a new host is effected through the air by means of the 'spray infection.' The spray consists of minute particles of germ-laden moisture derived from the infective mouth, fauces, nasal passages or nasopharynx of the sick person or carrier. When the spray is launched on the air in speaking, sneezing or coughing it may readily carry infection to others. In the open there is not much risk, as the atmosphere dilutes the spray and the breezes blow it clear, but hanging in the comparatively still air of enclosed spaces such as class rooms, dormitories and hospital wards, it has a high infective power at close range. The concentration of the infection varies inversely as the cube of the distance from the point of discharge and so falls off rapidly as the interval widens. The adequate spacing[1] of beds in dormitories and wards is therefore important. Among diseases commonly spread by the spray infection are cerebrospinal fever, chicken pox, diphtheria, infective coryza, influenza, encephalitis lethargica, measles, mumps, poliomyelitis, scarlet fever, smallpox and whooping cough.

Some insects, and especially those which are nourished upon the blood of man, may inoculate him, in the act of biting, with pathogenic organisms taken up from a previous case. This 'vector' action, as it is called, may be purely mechanical, or else the pathogenic micro-organism may undergo an essential stage of its life cycle in the insect body. Among the Arachnida some ticks and a larval mite are vectors. No tick-borne diseases of man are indigenous in Britain, but *Ixodes ricinus*, the sheep and dog tick of this country, may on occasion imbed itself in the human skin and lead to septic complications.

Portal of Entrance

The micro-organisms of infection find their most ready access to the body of man through the orifices of the mouth and nose. Some which gain ingress through the mouth with food or drink pass to the intestinal tract. Such are the bacilli of typhoid fever, tuberculosis and dysentery, and the vibrio of cholera. Others, which enter the mouth or nasal passages in the act of inspiration, may proliferate in the nasopharynx like the meningococcus, in the nasal passages or the fauces like *B. diphtheriae*, or in the parotid gland like the virus of mumps, or else may lodge and multiply in the lung like pneumococcus, *B. pestis* and sometimes *B. tuberculosis*. The mouth and nose are the obvious portals for all the spray-borne infections. For syphilis and gonorrhoea a way of invasion is provided by the moist surfaces of the genitalia, and for gonorrhoea by the conjunctival epithelium. Abrasions of the skin admit anthrax, wounds by biting may lead to hydrophobia or rat-bite fever, and punctures made by blood-sucking insects are access ways for the vector diseases. The specific agent of infective jaundice can infect through the unbroken skin.

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[1] Page 390.

IMMUNITY

Immunity to the infections produced by pathogenic bacteria may for the purpose of this section be classified as (1) Natural, (2) Acquired and (3) Induced Immunity. Natural immunity is an inherent quality. Acquired immunity is immunity which develops as the result of experience. Induced immunity is immunity established by artificial means.

Natural Immunity. Here the host, intervening on the threshold, destroys or disposes of the bacteria themselves as soon as they enter his body. This takes place in the process of phagocytosis, which is activated by the labile opsonin of normal blood serum. Normal serum itself may be directly bactericidal through the complement which it contains. Natural immunity, almost without exception, is active and antibacterial. It is known to be hereditary and to vary with species, race and strain. Thus man suffers from typhoid fever while cattle do not. Cattle on the other hand are subject to Texas fever, which does not occur in man. Natural immunity may be fostered in the lower animals by selective breeding, and in the vegetable world by selective culture. Despite the importance of natural immunity to man and stock animals its principles and mechanism are still imperfectly understood.

Acquired Immunity. This kind of immunity comes as the result of previous experience of bacterial activity. A person who recovers from an attack of an infectious disease acquires a specific immunity to that disease which may suffice to protect him against a second attack. The antigen formed by the infective micro-organism, as it proliferates in his body, calls up defences which promote his recovery at the time, and after his restoration to health continue to maintain his immunity for varying periods. The protection afforded by a survived attack is in some diseases strong and lasting. In others it is weak or short-lived, but probably never entirely absent. Carriers too can acquire immunity, which is again of a specific character though usually not so highly protective as that conferred by an attack. Even, however, without a preceding attack or any known experience of the carrier state a native of a populous city may gradually acquire immunity to some spray-borne diseases by receiving from his childhood and school days onwards repeated subinfective doses of floating infection in his neighbourhood. By the time he reaches adult years he has insensibly built up an immunity which contributes usefully to the mass immunity of his area. Acquired immunity may be either antibacterial or antitoxic. It is almost invariably of the active type, though the low incidence of diphtheria and other common infectious diseases observed during the earlier months of infancy points to an evanescent passive immunity derived prenatally by the infant through the chorionic epithelium from the maternal blood.

Induced Immunity. Immunity may be induced in man by artificial means, either with the object of fortifying him against invasion by pathogenic bacteria or in order to cure him of a bacterial disease from which he may already be suffering. Induced immunity of this kind may be either active or passive, and either antibacterial or antitoxic. When induced with a view to prevention it is Immunoprophylaxis, noted later[1]: when induced with a view to cure it is Immunotherapy, for example by the use of vaccines for furunculosis and gonorrhoeal arthritis, meningococcus antiserum for cerebrospinal fever and antitoxin for diphtheria.

Serum Disease. The syndrome to which this name has been attached may develop during the induction of immunity in the human subject when the active substance is administered parenterally in a heterologous serum. It occurs in man mainly with horse serum, being rare with sera derived from the ox or goat. It has been frequently observed after the therapeutic injection of diphtheria antitoxin contained in horse serum. The reactions, in which the antitoxin itself has no part, may be classed as one-dose and two-dose reactions respectively.

The one-dose reaction begins usually 8 to 12 days after the dose has been given. In exceptional cases it may appear almost immediately, or it may be delayed up to 3 weeks. The symptoms include pyrexia, vomiting and oedema, together with joint pains, chiefly metacarpo-phalangeal, and morbilliform, scarlatiniform or urticarial eruptions. The larger doses of serum are more disturbing than the small, and the intravenous route more predisposing than the intramuscular. The globulin fraction of the serum is comparatively inactive. The one-dose reaction is allergic in character, the allergin being an unidentified substance contained in the heterologous horse serum.

The two-dose reaction follows a second injection of the serum when administered 12 days or more after the first. It always follows close on the second injection and may supervene at once. The symptoms are of the same type as those of the one-dose reaction, but the attack tends to be moderately severe and may even terminate fatally. The two-dose reaction is anaphylactic, the patient having been supersensitised by the anaphylactin contained in the first dose of the serum.

PROTOZOAN IMMUNITY

Protozoa, especially when they set up subacute and chronic infections, may lead to the appearance of antibodies in the blood. But this reaction only occasionally serves to kill off the parasites, and frequently, as is well seen in malaria, the disease pursues a relapsing course. The same is true of many spirochaetal infections. In such cases immunity to reinfection is often observed in the sense that the early acute symptoms do not follow after fresh inoculations, but if once the parasites are completely destroyed in the body, for example with the aid of chemo-therapeutic agents, susceptibility to reinoculation soon becomes manifest.

VIRUS IMMUNITY

In some virus diseases, like measles, mumps and yellow fever, the acquired immunity which follows an attack is of high grade and long duration and in consequence seldom permits a second attack. This is, however, not an invariable character of the group, for in herpes and infective coryza the protection resulting from an attack is fugitive and weak. There are grounds for the view that virus immunity as exemplified by these diseases is mainly though not entirely due to antibody formation. Virus immunity may be active or passive. In smallpox, active virus immunity may be induced by the administration of the weaker kindred virus of vaccinia. In hydrophobia a similar result can be achieved with the attenuated virus of the disease. In measles during the course of an attack an antibody to the measles virus appears in the blood of the patient. Hence the blood serum of convalescent measles cases is used to confer passive immunity to measles on children exposed to infection.

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[1] Page 425.

PREVALENCE

An infectious disease which exhibits a standing prevalence in a country or a part of it is said to be *endemic* there. If the cases are scattered, occurring singly without prominent local foci, it is *sporadic* prevalence. When the disease assumes a spreading form, with numerous cases linked in sequence, it is an *epidemic*. An epidemic prevalence of world-wide or world-perturbing range constitutes a *pandemic*. For animal infections the terms 'enzootic' and 'epizootic' have the same significance as is possessed by 'endemic' and 'epidemic' in relation to the diseases of man.

Propinquity Diseases

The degree of propinquity, or nearness of people to one another, affects the length of the path of infection of any disease which passes from person to person, but is of special interest in connection with the spray-borne diseases which are transmitted by the agency of the buccal or nasal spray. For the control of the spray-borne group we may endeavour either to bar or to lengthen their path of infection in the air. Owing to the active comings and goings of people leading the ordinary communal life not much can be effected in these ways during the daytime, but during the hours of immobilisation in sleep the aerial route may be barred in houses by causing the people concerned to sleep in separate rooms, and in residential schools by the use of individual cubicles. In hospitals the result may be achieved by screening beds off or employing one-bed wards.

The path of spray-borne infection, where not barred, can be lengthened in barrack rooms, dormitories and hospital wards by the process of 'spacing out,' which for practical purposes means increasing the distance between the heads of sleepers. Through the rapid decrease of the intensity of infection with distance, an apparently slight increase of space may tell. Dealing with troops in barracks J. A. Glover found that, with an increase of the distance between beds from 1½ to 2½ feet, a soldier could sleep for 8 hours next to a meningococcus carrier without contracting infection. The distance between the men's heads can be increased also by setting alternate beds out from the wall, or by 'head and tailing,' that is to say, arranging the beds so as to be alternately head and foot to the wall. For residential schools there is an official recommendation that the distance between beds in dormitories should be not less than 3 feet, and between beds in sick rooms not less than 6 feet. For a general hospital 5½ feet between beds is an adequate figure. For wards in infectious diseases hospitals the Ministry of Health have advised a wall space of 12 feet per bed, equivalent to 12 feet between the heads of sleepers or, taking a hospital bed as 3 feet broad, 9 feet between beds.

This spacing out of beds in institutions, in addition to its use in emergency for the control of outbreaks of specified infectious disease, is of value as a standing precaution against less defined communicable conditions, such as catarrhs of the upper respiratory tract or ear, which once started are apt to spread in dormitories. In the wards of infectious diseases hospitals, spacing out helps to safeguard patients against invasion by streptococcal and other types of bacteria which, passing from case to case, set up complications of the original disease either dangerous in themselves or tending to result in discharges which prolong the period of infectivity. It protects also against apparent relapses occasioned by a new strain of the specific contagion introduced to the ward by some recently admitted case. It should however be kept in mind that certain viruses, especially those of measles and influenza, may exhibit a degree of infectivity which seems to baffle every precaution.

Spacing out should be reinforced by an adequate and fully employed system of cross-ventilation or by the use of wards with sliding roofs and folding sides. In good weather infected troops may bivouac with advantage: as already noted, the infective spray is powerless in the open.

Season

Most of the infectious diseases of Britain are influenced by the seasons. Without being limited to a particular period, they show in general a seasonal preference which is fairly constant for each.

First Quarter. Encephalitis lethargica and pneumonia prevail in the first quarter of the year. There is a rise of whooping cough at the end of the first quarter, which carries over into the second. Smallpox and cerebrospinal fever begin during the first quarter and continue through the second. Typhus is mainly a disease of the first quarter. In London over a period of 36 years the maximum influenza mortality was in the month of March. During the cold of the first quarter people seek comfort indoors and so are specially exposed to the dangers of spray infection. This indoor crowding favours also the migration of lice from person to person. Hence the rise of typhus.

Second Quarter. During the second quarter, in the month of May, measles shows an upward movement which persists through June and into July.

Third Quarter. The principal diseases of the third quarter are infantile diarrhoea and poliomyelitis. Infantile diarrhoea has been ascribed to fly prevalence which, though a diminishing factor, is still highest in autumn. Invasion by the causal agent of poliomyelitis may be aided by the dusty atmosphere of dry autumn weather.

Fourth Quarter. During the fourth quarter diphtheria, scarlet fever and typhoid fever exhibit their maximum prevalence. The increase of cases of typhoid fever follows upon the maximum fly prevalence and may be related to it. The measles curve makes a second ascent during the fourth quarter and continues high into the succeeding year. Diseases prevailing overseas, such as malaria and plague, exhibit similar seasonal tendencies.

Madsen has expressed the view that in north-west Europe the seasonal oscillation of daylight between its maximum at the summer solstice and its minimum at the winter solstice is a primary factor in raising and lowering the bodily resistance and so affecting the seasonal prevalence of infectious diseases.

EPIDEMIOLOGY

Epidemiology is the study of infection as exemplified in the epidemic, its most arresting form. It is a study in the mass, concerned not with the individual who sickens and dies or recovers, but with the sum total of such individuals as determined by the range of the epidemic. The numbers involved may on occasion be reckoned in millions. They are commonly large enough to admit of statistical handling.

In the course of an epidemic of a propinquity disease developing freely among a stationary population, if we point off on squared paper the number of cases sickening week by week and thereafter draw a smooth line through the points marking these values, we shall find that the resulting curve tends to be bell-shaped and symmetrical as shown in Figure 100. It will be observed from the figure that the curve rises slowly at first. Then, gathering force, it climbs to a peak, from which it descends at the same incline as when it went up, and finally subsides gradually to its termination. This ordered sequence of cases in epidemics was first remarked by W. Farr in 1840, in connection with the then recent outbreak of smallpox in England. In practice, as observed by him, the curve may be asymmetrical, owing to disturbing influences which prolong its rise or decline, usually the latter. Allowing for such irregularities, the 'epidemic curve' is now recognised to be of similar type to the normal probability curve of mathematics, which is represented by the equation

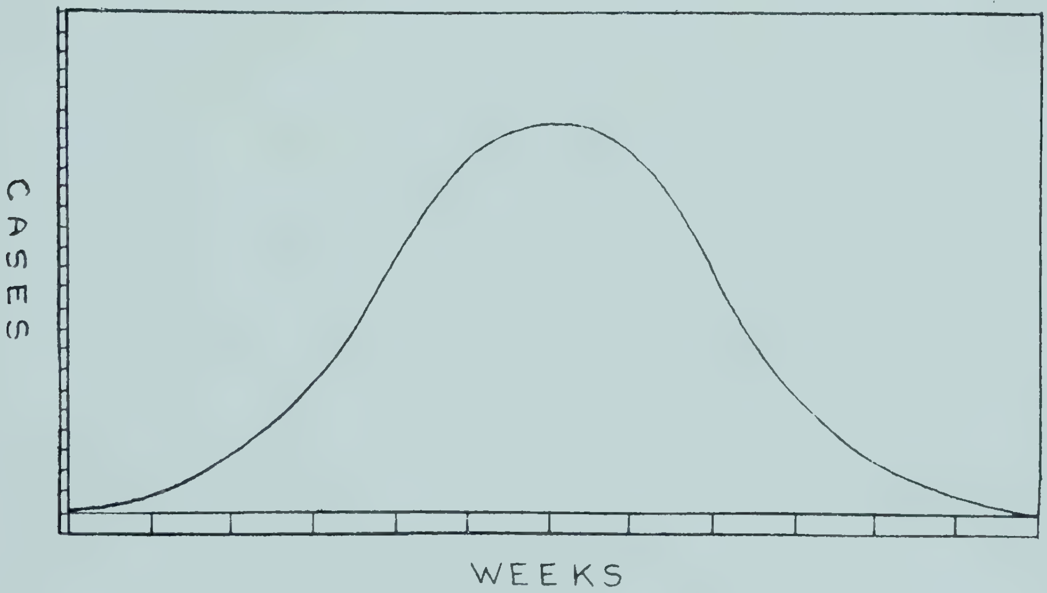

Fig. 100.—Epidemic Curve.

$$y = e^{-x^2}$$

e being the base of the Napierian logarithms. This equation gives a curve symmetrical about its longest ordinate. It is most typical of the person-to-person infection in the propinquity diseases.

For the production of an epidemic, either the causative micro-organism must develop adequate infective power, or else the population at risk must become sufficiently receptive, or both of these conditions may be fulfilled. In view of the fact that the virulence of micro-organisms can be exalted artificially by animal *passage*, it seems entirely credible that their infectivity also may be capable of intensification in a kindred way, through the agency of natural processes and in relation to the human subject. It was held by J. Brownlee that there could be from time to time a self-originated increase in the germinal vitality of bacterial strains leading, as in human affairs, to great, but not necessarily good, achievements. Thumb-nail sketches of the catastrophic progress of three famous outbreaks will serve to confirm these speculations. Beginning A.D. 165, smallpox scourged the Roman Empire for 15 years. The Emperor Marcus Aurelius was numbered among its victims, and 'all was death and infection from Persia to Gaul.' The Black Death, which broke out in 1346, had by 1351 swept every country in Europe. Great tracts of land were laid desolate and 25,000,000 people lost their lives. Cholera during the nineteenth century, passing the bounds of its native Bengal, five times bestrode the world in fatal pandemics. The fourth of these was responsible for 14,378 deaths in Britain and the fifth for 151,563 in Japan. Each of these visitations, one in old Rome, one in the Middle Ages, and the last in modern times, conveys to the mind the impression of a dominant force, which proved its power by a soaring death-roll wherever it was exerted.

There is evidence that the high receptivity of populations by reason of a low or non-existent immunity is favourable to the development of epidemics. 'Virgin soil,' where the disease concerned is either unknown or dimly remembered, is apt to become the scene of an epidemic whenever the opportunity presents itself. Thus, in 1846, when the Faroe Isles had been free of measles for 65 years, a carpenter from Copenhagen was landed at Thorshavn incubating the disease. Of the Island population of 7782, six thousand took measles. Again, in Fiji in 1874, the son and one of the retinue of the Chief sickened with measles on the voyage home from Sydney and reached the Islands in an infective state. Measles was a new disease to these distant shores, and in the course of the ensuing epidemic one-fifth of the total inhabitants of Fiji were fatally stricken. A similar infliction may follow when a group of receptive persons is brought into an area which is familiar with measles. In 1914, on the outbreak of the First World War, the Territorial Highland Division was sent for training to a place in England where measles was endemic. The Division was largely composed of men from secluded Scottish glens and islands. Soon after their arrival in camp measles broke out among them. In three months they had 518 cases with 67 deaths.

A further instance of the influence of receptivity in precipitating epidemics is afforded by the recurrent outbreaks of infections commonly endemic in large cities. This periodicity, which is exhibited with more or less regularity every few years, has to do with the total or 'herd' immunity of the populations concerned. Since an attack of any of these diseases confers some protection, every patient who recovers adds to the strength of the herd immunity, and an outbreak ends when the herd immunity, swelled by these and other acquisitions, rises to the effective level and arrests further progress. Then, as time passes on, the make-up of the population alters. Children are born, immunes die or leave the city, and newcomers take up residence. In a few years the herd immunity has been diluted below the effective level. That is to say, the people have become receptive and, the disease being endemic in the area, another outbreak is due. This periodicity is evident in the case of measles, epidemics of which, with occasional omissions, tend to occur in alternate years. For scarlet fever an interval of 4 years was observed in London and one of 5 years in Glasgow. In pre-vaccination days the town of Kilmarnock, according to records kept, was ravaged by smallpox every 4 years. A 6-year period between epidemics of cholera has been noted in endemic areas.

In addition to the short-term periodicity described above, there has been traced in epidemics a rather irregular long-term periodicity with intervals ranging, it may be, up to 30 or 40 years. This propensity is well-marked in the incidence of influenza. In the sixteenth century there were 4 major epidemics of the disease: in the seventeenth 2 and in the eighteenth 5. The first half of the nineteenth century witnessed 4 great outbreaks, in 1830, 1833, 1836 and 1847. Next in order, after 42 years, came the pandemic of 1889-90. Springing, it is said, from Bokhara, this infection reached St. Petersburg. Thence it spread across Western Europe, and later moved on to the United States, Australia and New Zealand. Thirty more years passed and then, in the closing months of the First World War, there developed the influenza pandemic of 1918-19. It is believed to have originated on the Pacific coast of North America, whence it made its way to the North Atlantic shore. Conveyed across that Ocean in ships, it reached ports in Western Europe and spread its infection there. It came to Britain in the summer of 1918 and by December of that year had invaded distant and dissimilar places in every continent of the world. In England 150,000 died, in Scotland 17,575, in the United States 450,000 and in India 4,900,000. The influenza pandemics are much more suggestive of intenser virulence developed by the virus than of any other cause.

Oscillations in the severity of infections introduce an ill-defined third periodicity into their epidemics when they occur. Scarlet fever in the seventeenth century, as observed by T. Sydenham, was a very mild disease. He called it *hoc morbi nomen* in describing it, and did not mention sore throat as a symptom. At the end of the eighteenth century it is known to have been malignant. Early in the nineteenth century it was comparatively benign. Then for a generation it was 'a leading cause of death.' Now it is milder again. Diphtheria also has had its exacerbations. Twice during the nineteenth century from 1860 to 1864 and from 1883 to 1893 it was notably fatal in Britain. Between 1583 and 1666 Spain was severely afflicted. The peak year was 1613, known as *año de los garrotillos.*

If an epidemic is to attain to formidable dimensions, its 'setting' must aid. That is to say that, apart from the infective power of the micro-organism or the receptivity of the population at risk, there must be facility for the transmission of the disease. If the setting is unfavourable, the infection may smoulder for a little while, but it soon dies out or reverts to the endemicity from which it rose. In organised communities during peace such facilities are usually at average level. While air-conveyed outbreaks of measles, scarlet fever and the like may occur at intervals, the squalor-engendered infections, such as typhus and relapsing fever, are almost unknown. But amid the turmoil of war this setting abruptly changes in favour of the epidemic. In occupied towns with, say, the local water supply ruined, the sewers out of commission, houses wrecked, food scarce and inferior, and hospitals either razed or overcrowded, people who have no means of ablution, or of changing their clothing, huddle together for warmth and shelter in what buildings survive, and so ensure the free transmission among themselves of any louse-borne or other propinquity infection endemic in the area.

War has indeed throughout history been a nursery for epidemics, which have usually caused far heavier losses to armies than those resulting from their encounters with the enemy. Often both sides have been affected by the same disease, and the civilian population at the scene of hostilities have frequently suffered most. Countless instances are known of the association between campaigns and epidemics. A few are cited here.

The fatal, but rather obscure, Attic sickness of B.C. 430 raged in Athens during a siege. In B.C. 62 the troops disbanded by Pompey after the Eastern war disseminated leprosy in Italy. Between A.D. 531 and 580 the plague of Justinian, combined with wars and earthquakes, led to the death in the Roman Empire of 100,000,000 people. In 1270 Louis IX of France, after embarking on the Seventh Crusade, turned aside to attack Tunis. Plague, which prevailed in the town, involved the French army also and the King died of it. Thereupon the Crusade was abandoned, and Prince Edward of England, afterwards Edward I, went on alone to Palestine. In 1346 the town of Kaffa, now Theodosia, in the Crimea was enclosed by a Tartar army. Plague developed among the Tartars, who set up their siege catapults and slung their dead into the town. This procedure was perhaps more disquieting than dangerous but, by this way or another, Kaffa too became infected. Then three Italian galleys, bound for home, escaped from the beleaguered town. On the voyage all three ships proved to be plague-infected. One put in to Genoa, one to Venice and one to 'another place in Christendom.' Wherever they touched they aided the Black Death, which is plague, in its advance over Europe. In 1348 the infection reached Calais, which was then in English hands, having been taken from the French in the previous year. Some English troops were shipped home to Melcombe Regis in Dorsetshire. They proved to have been plague-infected, and the Black Death was loosed on England. In 1485, before Bosworth Field, Henry Richmond's Norman archers, invading by sea at Milford Haven, introduced the sweating sickness, which spread over England and elsewhere in five severe epidemics.

Typhus fever appeared in the Spaniards' camp at the siege of Granada in 1489, and since then has been a complication of most military enterprises of note in Europe. In 1528, after the sack of Rome, troops of the Emperor Charles V. were encircled in Naples by a French force. The Imperial troops were short of food and on the point of capitulation, when typhus so forcibly smote the besiegers that their army melted away. In 1643 at the siege of Reading it assailed both the garrison and the Parliamentary army. It raged in Germany and elsewhere during the Thirty Years War of 1618-48, and again during the Seven Years War of 1756-63. In 1812 it pursued the French army in the retreat from Moscow. In 1855-56 it caused grievous losses in the Crimea. In 1877-78 it beset both armies in the Russo-Turkish War. During the First World War the deaths from typhus in Serbia in one winter amounted to 150,000. In the five years following the armistice the cases of the disease in Russia were close on 7,000,000. The influenza pandemic of the First World War has already been referred to. It did not originate from war conditions and its occurrence during the War seems to have been fortuitous. During the Second World War the city of Naples, when abandoned by the enemy, was left in a plight strongly favourable to the transmission of typhus, and typhus broke out.

The seasons influence epidemics, which are apt to begin or to intensify when their season of prevalence comes round, bringing with it the setting most favourable to their spread. In addition, an epidemic may adapt itself to the season. When the Black Death came to Avignon in January, 1348, for the first two months the patients 'spat blood and died in 3 days.' When spring came with its milder weather they developed buboes instead and lived for 2 days longer. So said Guy de Chauliac, recounting what he had seen. Climate too may influence epidemics. It may determine their location. Outbreaks of yellow fever in the Old World occur only in the belt between latitudes 15° N. and 10° S., such being the climate appropriate to the vector mosquito. For a similar reason epidemics of sleeping sickness in Africa have been restricted to tropical and subtropical climates. On the other hand, neither smallpox nor malaria is fettered by climate, though the major incidence of the latter is in warm areas. Pandemics of plague and influenza have ranged the world regardless of climate. In the cold of the Manchurian winter two severe epidemics of plague, one in 1910 and the other in 1920, assumed the pneumonic form.

Epidemics seldom proceed to the total extinction of the populations which they afflict. When a cultivated tract is left a wilderness after the passage of a pestilence it should be kept in mind that many of the people may have sought and found safety in flight. Where however flight has been either prevented or scorned, epidemics have on occasion come near to using up all the population at risk. An example of flight prevented is the French town of Digne. Typhus broke out there in 1629, and in order to 'keep the fever in' the place was encircled by troops and all egress barred. The town gates were closed in June of the year specified. When they were opened in April, 1630, of 10,000 people only 1500 survived and of these all but 5 were recovered cases. A fine example of flight scorned was set by the village of Eyam in Derbyshire, into which the plague broke in 1666. Rather than stampede from the village and distribute the infection over the country-side the people resolved to ring themselves in from the adjacent healthy district and see the business through. When their public-spirited seclusion began they numbered 350. A year later, when the infection had spent itself, only 30 were left alive.

In general it may be presumed that an epidemic comes to an end by an inversion of the procedure with which it began, that is to say, either by enfeeblement of the bacterial impulse, or by a lowering of the receptivity of the people, which is the same thing as a heightened immunity. Either way the resulting curve still keeps the epidemic form. The effect of a heightened immunity upon the number of cases infected was observed, as shown in Figure 101, by S. F. Dudley in connection with outbreaks of diphtheria in boys at the Greenwich Naval School. In each of the three outbreaks, but best seen in the central and largest, the herd immunity curve rises, determined by Schick-negative reactions, and as it goes up the case frequency comes down and finally touches the zero line. Though seldom capable of being thus confirmed by specific reaction tests, the course of events leading up to the termination of epidemics of other diseases may be of a similar order. When we add to the recovered cases, who are immune, others who have become carriers and are also immune, and still others who have been subclinically infected and are likewise immune, we can see how an epidemic, as it proceeds, may build up a wall of resistance against itself, which in the end bars further progress. So it must have been in Glasgow in the winter of 1907-08, when there took place one of the most extensive epidemics of measles experienced in the city, and yet in the summer of 1908, when the outbreak was over, the fever hospital records showed that close on 50 per cent. of the children admitted with other diseases had, so far as could be ascertained, never had measles. Very many children must have survived the winter outbreak unsmitten. For the closing down of other epidemics other causes may have been operative. The smallpox outbreak in London of 1901-02 may have stopped at 8000 cases either because the virus had waned, or because the setting had altered, opportunities for the transmission of the infection having become too infrequent.

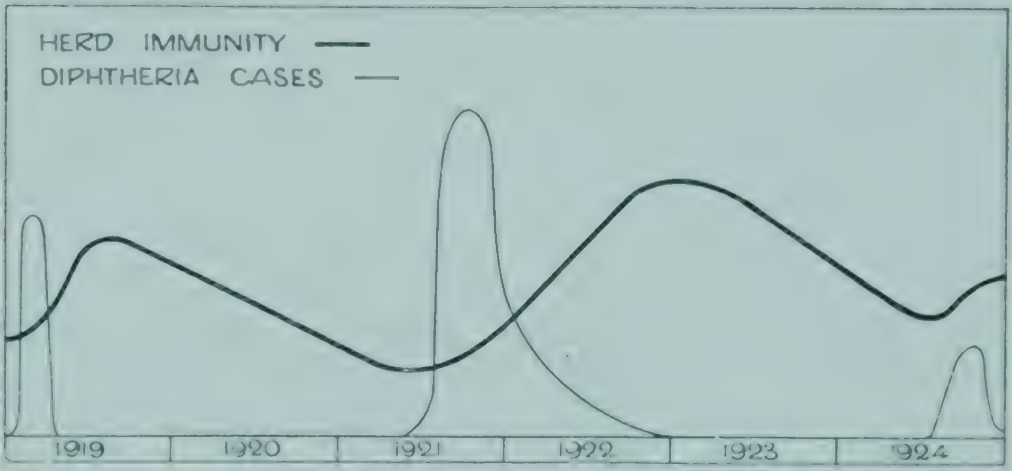

Fig. 101.—Herd Immunity.

As the immunity curve rises the case frequency falls.

In Palestine from 1921 to 1926 the prevalence of typhoid fever kept on increasing year by year. It was observed that the rise of each year over its predecessor became apparent soon after the admission to the territory of its annual quota of susceptible Jewish immigrants. In Senegal, yellow fever slumbers among the native population in the form, it is believed, of a widespread endemicity of mild cases. In 1926 there were landed at Dakar 200 healthy Syrian immigrants. Before long, yellow fever showed itself in the area in an outbreak which ran to 34 cases, 16 being Syrian immigrants and 18 resident Europeans. At Greenwich Naval School, as reported by S. F. Dudley, an epidemic of influenza was on the point of extinction on its 23rd day, when it was lit up again by the introduction of 40 new boys. Ten of the new boys sickened: the old boys had a higher case frequency than ever and began to develop second attacks. The introduction of 40 more new boys on the 47th day of the outbreak had a similar but milder effect, and the epidemic was prolonged to its 68th day. All three of these occurrences took place in communities which were for practical purposes closed, and the lesson is that when an epidemic in an occupied area is latent or drawing to its conclusion, any admission of healthy immigrants should be carefully controlled. The rationale of the course of events was made clear by the work of M. Greenwood and W. W. Topley in their study of the epidemic experience of a closed community of mice. They found that when a *Pasteurella* infection was on the point of expiring, it could be revived by the introduction of healthy mice, which not only died of the disease themselves, but also caused a recrudescence of mortality among the general stock. The recrudescence was doubtless owing to the exaltation of the bacterial virulence by *passage* through the fresh susceptibles.

The social and political changes brought about by great epidemics cannot be enlarged upon here. Suffice it to say that they have been both numerous and remarkable. Regarded as phenomena, epidemics may often be impressive by reason of the range and dimensions of the ruin which they inflict, or by the pertinacity with which they seem to move towards their grim successes. Prophylaxis can, however, flatten or distort their curves, and they may on occasion engage in a venture foredoomed to failure, as recounted in the following narrative.

The wooden barque *Hecla,* 475 tons gross, sailed from Cuba, bound for Swansea, on 26th July, 1865, with cases of yellow fever on board. Others sickened on the voyage so that the ship reached Swansea on 9th September with one case dying and two convalescent. On 15th September, 6 days after her arrival, yellow fever broke out among Swansea people who had visited her in harbour. She left Swansea by request on 28th September, but new cases continued to appear till 4th October, 6 days after her departure, making 20 in all. Three more fell sick in the port of Llanelly among the crew of a small craft which had lain alongside *Hecla* in Swansea harbour. Being a wooden ship *Hecla* had ample water in her bilges. Aëdes mosquitos which she brought from Cuba could thus breed on the passage, and their young, being infected by the sick on board, were able on their arrival in Swansea to spread the disease anywhere within their range of flight. When the Cuban mosquitos died off, no British mosquito could assume their vector function. The outbreak accordingly ended at this point.

The Epidemiology of the Second World War has not been fully explored at the time of writing, but from information so far published it may be gathered that in Continental Europe two only of the five pestilential diseases assumed epidemic proportions during the period. These were typhus fever and smallpox.

Typhus prevailed in the German Reich as far west as the Rhineland, and also established three epidemic centres in south-eastern Europe. For two years the disease harried Spain, totalling 11,000 cases. The outbreak in Naples during the winter of 1943-44, referred to in the second edition of this book, produced in the end not much more than 1000 cases, having been checked by the cleanliness imposed by our troops on the people, aided by D.D.T.

Smallpox of the classical type reached Greece from Turkey. The same disease early in the War was rife in Spain and Portugal, but gradually spent its force. There was a prevalence of *Variola minor* in Italian territory, centring on Palermo and Naples. The cases numbered 1500, with only 6 deaths, and these only of debilitated children.

As regards the three remaining pestilences neither cholera nor plague nor yellow fever invaded Continental Europe during the hostilities, but in the autumn of 1945 23 cases of plague, with 11 deaths, were reported from Taranto.

Diphtheria stands out on this occasion as the worst War infection in Continental Europe. In 1942 some 15,000 people died in the area from this disease. In 1943 the cases numbered at least a million. Of these, 300,000 were in Germany. In three years the Netherlands had 150,000 cases, and Norway and Finland were both heavily stricken. The most threatening feature was not so much the frequency of the cases as the increasing mortality among those who fell sick. Some were severe croupous types. Some simply proved refractory to all serum treatment. Diphtheria was a principal cause of death to the German army. To some cases it was the terminal complication of typhus or wounds of the chest. Scarlet fever was as widespread as diphtheria but less fatal.

Poliomyelitis during the War period had a higher prevalence on the Continent than in the British Isles. In 1943 the disease was epidemic in Sweden, the Netherlands and Central France. In 1944 Denmark, Switzerland and again Sweden were the areas afflicted.

Typhoid fever increased as little in the Scandinavian countries as in the United Kingdom, but the position changes for the worse as we pass from north to south. In Central Europe the incidence of the disease was double the pre-war figure. In France it was nearly three times as high. Italy in 1942 was responsible for half the known typhoid cases in the whole Continental area. In Greece the proportion of cases was 133 per 100,000 of population. In Spain the corresponding figure rose to 200.

Paratyphoid fever in Northern Europe caused from 2 to 5 times as many cases as typhoid fever. In Southern Europe the paratyphoid cases constituted a mere fraction of the total enteric group.

Dysentery of the bacillary type exhibited an uncertain but undoubtedly large excess of cases above the pre-war level. The most common strain was happily the mild *Sonne E*. In the German army the strains were *Flexner* and *Hiss Y*. Among prisoners of war the *Shiga* strain was most prevalent.

Epidemic hepatitis has qualified as a War disease. Originating, it is believed, from the garrison of Malta or some German unit, it moved northward in such growing strength as to interfere with military operations and to make its unwelcome presence felt by the civilian population. It appears to have become widespread in Germany. It is known to have smitten in Norway from 1 to 5 per cent. of the population. The disease was made notifiable in the three Scandinavian countries together with Switzerland and Finland. The cases reported in the five countries in 1943 numbered 65,000.

Cerebrospinal fever in the early stages of the War increased above the normal owing to the concentrations of troops. After 1941 there was a gradual decline. The case frequency, with some exceptions, was lower on the Continent than in Britain.

Influenza showed a peak in the winter of 1943-44. There was however no pandemic like that of the First World War, regarding which we wrote in the Second Edition of this book, 'It did not originate from war conditions and its occurrence during the War seems to have been fortuitous.'

Malaria during the last two years of the period was epidemic in Greece. What is described as high epidemicity oppressed the Balkans and Italy, and owing to the forced migrations threatened adjacent territory. *Falciparum* infection was the rule in the south of the Continent, *vivax* in the north.

Syphilis in the Scandinavian countries, Finland, France and Germany increased threefold and up to ninefold. All the progress made in the peaceful years was thus obliterated.

Gonorrhoea was held in check for a time by sulphonamide. Later, virulent sulphonamide-resistant strains came under notice.

Tuberculosis was stationary over the area in 1939 and 1940. In 1941 the disease began to spread. Great Britain, the Scandinavian countries and Switzerland put up a useful resistance, but in parts of France, Germany, Austria, Czechoslovakia and Hungary the infected cases doubled in number. The situation in the Low Countries, the Balkans, Poland and Italy at the close of the War can only be described as in general bad with the risk in some areas of becoming worse.

XVIII.

PREVENTION

INFECTIOUS diseases may be prevented by taking action against the life or energies of their causative micro-organisms, which are usually most accessible to attack in the open, while in course of transmission from host to host. The action taken should be adjusted so as to cope with the particular micro-organism concerned. The more we know of its exits and its entrances and its habits of life generally, the better are we able to frustrate its noxious activities. In some diseases we can turn to account the methods of immunoprophylaxis so as to kill or inactivate the germ within the body of the host.

DIAGNOSIS

If preventive measures are to be well adjusted, a correct and early diagnosis of the disease from which an infective person is suffering is obviously important. Delay in recognising a case of smallpox and in getting the patient securely isolated may start an epidemic. The diagnosis of a common infection with its typical exanthem well out will give the practitioner little difficulty. The pre-eruptive stage of measles and the prodromal rashes of smallpox he may not find so easy. In any case where he is in doubt he may call into consultation the medical officer of health or one of his medical staff. He has also at his disposal the public health laboratory service, to which he may send, for example, cerebrospinal fluid to be examined for the presence of the meningococcus, blood for the agglutination test in typhoid or paratyphoid fever, or a throat swab from a suspected case of diphtheria. When there is doubt regarding the nature of the specimen which should be sent, guidance is available from the laboratory. Care should be taken when transmitting pathological specimens to ensure that containers and packages conform to postal regulations. Official containers and envelopes may be obtained from medical officers of health and public health laboratories. These laboratory tests are of unquestioned confirmatory value, but, if the need is pressing, action should be taken on the clinical facts without waiting for the laboratory report. In the case of diphtheria, which is always pressing, antitoxin should be given when the swab is sent to the laboratory, not delayed till the report comes back. Furthermore it should be remembered that, while the finding of diphtheria bacilli points to the presence of diphtheria, a laboratory report 'diphtheria bacilli not found' does not inevitably rule diphtheria out.

NOTIFICATION

With a view to speedy action by the local authority in order to prevent the spread of infection, cases of infectious disease are required to be notified to the Medical Officer of Health by medical practitioners and others under (1) the Public Health Act, 1936, and (2) a number of Public Health Regulations made since 1900 by the Minister of Health.

Public Health Act, 1936. The infectious diseases notifiable under this Act are:

Smallpox
Cholera
Diphtheria
Membranous Croup
Erysipelas
Scarlatina *or* Scarlet Fever
Typhus Fever
Typhoid Fever
Enteric Fever
Relapsing Fever.

When an inmate of any building used for human habitation, other than a fever hospital, is suffering from one of the named diseases every medical practitioner attending on or called in to visit the patient must, as soon as he becomes aware that the patient is so suffering, send to the Medical Officer of Health a certificate giving the name and address of the patient and stating the disease. In addition the head of the family, or his substitute in terms of the Act, must send notice of the disease to the Medical Officer.

The fine for non-compliance is up to forty shillings. The local authority must supply notification forms to practitioners free of charge. The doctor's fee for each notification is 2s. 6d. in private practice and 1s. in an institution. The Act applies to cases in buildings occupied by His Majesty's forces: for the notification of such cases civilian practitioners are entitled to receive a fee of 1s.

Besides the diseases named above, other infectious diseases may be made notifiable by a local authority within its own area, on either a temporary or a permanent basis. The Order issued by the local authority, unless in case of emergency, cannot take effect until approved by the Minister of Health. It must be duly advertised in advance and a copy of the advertisement sent to every doctor practising in the area.

Public Health Regulations. The following are due to be notified by practitioners under these Regulations:

Plague
Cerebrospinal Meningitis
Acute Poliomyelitis
Tuberculosis
Ophthalmia Neonatorum
Encephalitis Lethargica
Malaria
Dysentery
Acute Primary Pneumonia
Acute Influenzal Pneumonia
Puerperal Pyrexia.

The Regulations allow delay of 48 hours in the notification of tuberculosis. Malaria induced in mental hospitals for therapeutic purposes is not notifiable unless the patient on discharge is thought liable to relapses of malaria. Dysentery may be either amoebic or bacillary. In most respects notification procedure under the Regulations is on the same lines as under the Act. In October, 1939, by provisional war-time regulations which were confirmed later, Measles and Whooping Cough were added to the list of notifiable infectious diseases.

In Scotland the equivalent arrangements are: *Infectious Disease (Notification) Act,* 1889. Notifiable diseases are as in the English Act, with the addition of continued and puerperal fevers. *Public Health (Infectious Diseases) Regulations (Scotland),* 1932. Notifiable diseases are as in the English Regulations, with the addition of infective jaundice. Induced malaria is as in the English regulations. In Scotland all notifications are required to be made forthwith, no lag being allowed in the case of tuberculosis.

TREATMENT

Medical care and nursing, which promote the comfort and the recovery of an infectious patient, may tend to reduce the degree of his infectivity and shorten its duration. Occasionally, as in diphtheria, typhoid fever and gonorrhoea, the patient may remain infective long after his symptoms have disappeared. In the case of certain protozoal infections treatment has a direct preventive value. Quinine in malaria, tryparsamide in sleeping sickness and neokharsivan in relapsing fever drive the parasites from the peripheral blood, so that the insect vectors do not become infected and are unable to transmit the diseases.

The treatment and prognosis of the specific fevers have been greatly altered by the introduction of the sulphonamide drugs which include the amides of sulphonic acid and their substitution products. Beginning with the azo derivative sulphamido-crysöidin, commercialised as 'prontosil rubrum,' the group has been developed and extended until there are now upwards of eleven compounds possessing high therapeutic value. Amongst the more important are sulphanilamide (p-aminobenzenesulphonamide), sulphapyridine (p-aminobenzenesulphonamido-pyridine), sulphacetamide (p-aminobenzenesulphonacetamide) known also as albucid, sulphathiazole (p-aminobenzenesulphonamido-thiazole), sulphadiazine (p-aminobenzenesulphonamido-pyrimidine), sulphaguanidine (p-aminobenzenesulphonylguanidine) and succinyl-sulphathiazole (p-succinyl-aminobenzenesulphonamido-thiazole). Acetyl compounds of the above substances are also available for use in treatment.

The sulphonamide drugs are chiefly bacteriostatic and are most active in alkaline solution. They are of little avail against bacterial toxins. They are readily neutralised by enzymes and on this account their concentration in the blood must be maintained at a high level. In order, moreover, to prevent the bacteria from acquiring tolerance to the drugs, doses should be full and accompanied by a high fluid intake.

In sensitive persons, or as the result of overdosage, sulphonamide therapy may result in symptoms of toxaemia which include malaise, nausea, vomiting, cyanosis, lumbar pain, haematuria or anuria. Blood films may show agranulocytosis. Leucocyte counts should be made daily during the administration of sulphonamides and micro-chemical tests are available by which the blood concentration of the drugs may be determined at the patient's bedside.

The sulphonamide dosage for adults as recommended by the Medical Research Council is summarised in the subjoined table:

Period	Severe Infection	Moderate Infection
1st Day	2-4 grams intravenously	2 grams orally
2nd to 4th Days	1·5 grams orally 4-hourly	1 gram orally 4-hourly
5th and 6th Days	1 gram orally 6-hourly	1 gram orally 8-hourly

Children should receive proportionately smaller doses. Sodium salts of sulphonamide should not be administered intrathecally. The sulphonamides are also of value in prophylaxis, especially of streptococcal infections. The indications for the various sulphonamides in the treatment of the individual fevers are presented in their places under Community Diseases below.

Penicillin, developed by Fleming and Florey, is an organic acid extracted from fresh broth cultures of the mould *Penicillium notatum.* It is now available for the treatment of infections due to various bacteria, including *Streptococcus pyogenes, S. viridans, Staphylococcus, Pneumococcus, Meningococcus, Gonococcus, C. welchii, B. anthracis, T. pallidum and S. actinomyces.*[1] It is powerless against *V. cholerae, B. typhosum, B. dysenteriae, B. pestis, M. tuberculosis* and the viruses. Penicillin is effective in extremely high dilutions. It is non-toxic and is harmless to delicate tissues. Its sodium salt may be administered either intramuscularly or intravenously by drip transfusion. Doses are up to 200,000 Oxford units in 24 hours. Penicillin is an unstable substance and is decomposed by heat or moisture, by alkalis, by alcohol and by antiseptics. It should be kept in sealed ampoules in the refrigerator. Public Health laboratories are now equipped to undertake penicillin sensitivity tests of bacterial strains submitted. A check may be kept upon the adequacy of dosage during the administration of penicillin by means of a simple blood titration technique. In view of the vast quantities of the mould which have to be cultured in order to produce a small amount of penicillin, attempts are now being made to synthesise this substance.

When a therapeutic choice has to be made between penicillin and sulphonamide, it may in general be assumed that penicillin will prove the more active agent in cases where both are effective. This is particularly so in staphylococcal suppurations and in endocarditis due to *Streptococcus viridans.*

A similar antibiotic, streptomycin, is now undergoing trial as a therapeutic agent in tuberculosis, including tuberculous meningitis. The results have so far been conflicting. Other antibiotics under review include aspergillic acid, gramicidin and pyocyanase.

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[1] There is already some evidence that certain pathogenic bacterial strains may develop a tolerance to penicillin.

Stocks of antisera and other specialised remedial substances may be held by medical officers of health for issue free of charge to general practitioners as required.

ISOLATION

Isolation of the infective sick person is intended to cut across the path of infection, and if carried out under proper conditions, including adequate sick-room precautions,[1] may be expected to do so. The infective patient may be isolated either (1) in his own home or (2) in hospital.

Home Isolation

Isolation at home may be permitted, especially in the case of the minor infections, if a bedroom or an entire floor can be set aside for the patient, and adequate nursing facilities can be made available. Breach of isolation by the patient, and failure to maintain it by the person in charge, whether relating to the sick person himself or to articles presumed to have been infected by him, may be penal offences, as the following provisions show.

Persons. Under the Public Health Act, 1936, a person suffering to his own knowledge from a notifiable disease, who by his presence in a public place exposes others to risk, is subject to fine. So also is the person in charge if he allows a person so suffering so to expose others to risk. Further, a person so suffering is subject to fine if he engages in any trade or occupation in which he cannot engage without the risk of spreading his disease. He is subject to fine also if he enters a public conveyance used for the conveyance of persons at separate fares. In the case of a school child who is or has been suffering from a notifiable disease, or who has been exposed to infection by such disease, the Medical Officer of Health may notify the person in charge that the child is not to be sent to school, and the child may not attend school until the Medical Officer certifies that he may do so without undue risk of communicating the disease to others.

Where the body of a person who has died of a notifiable disease is lying in any premises, the person in charge must take all reasonable steps to prevent persons coming unnecessarily into contact with the body. It is not lawful to hold a wake over the body of such a person. In the case of *any* dead body the retention of which in a building would endanger health, a Justice of the Peace on the certificate of the Medical Officer of Health or other registered medical practitioner may order the body to be removed to a mortuary at the cost of the local authority and buried within a specified time. Or alternatively the relatives within that time may cause the body to be cremated.

Articles. Under the Public Health Act, 1936, it is forbidden to give, lend, sell or expose, without previous disinfection any infective clothing, bedding, rags or other articles. It is forbidden to take or send any infective article to a laundry or public wash-house, without previous disinfection to the satisfaction of the Medical Officer of Health or of some other registered medical practitioner. If the article is sent to a laundry for the purpose of disinfection, it must be sent with proper precautions and notice given that it has been exposed to infection. A person suffering to his own knowledge from a notifiable disease who uses any book taken from a public or circulating library is subject to fine. So also is any person who permits any such book which is under his control to be used by a person so suffering. The book in question is not permitted to be returned to the library, but a notice about it must be given to the local authority, who must either disinfect the book or else destroy it. It is forbidden to place in a dustbin or ashpit any matter exposed to infection which has not been submitted to disinfection. A local authority may make an order forbidding an occupier of a factory or a contractor to issue work on wearing apparel or similar work to any person living or working on premises where a case of notifiable disease has occurred.

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[1] Page 432.

Similar provisions hold in Scotland with regard to both infective persons and articles, library books excepted, under the Public Health (Scotland) Act, 1897, and other statutes.

Hospital Isolation

Persons suffering from smallpox, typhus, cerebrospinal fever or other major infection, should, as a rule, be isolated in hospital. The same precaution should apply to all infective cases who are living in an institution or tenement property or in a crowded quarter of a town, or in a van or on board a ship in harbour.

Removal to Hospital. Under the Public Health Act, 1936, a person suffering from a notifiable disease may by the order of a Justice of the Peace be removed to hospital, if proper precautions cannot or are not being taken to prevent the spread of infection, if serious risk of infection is being caused thereby and if suitable hospital accommodation can be got. The local authority may provide an ambulance for the conveyance of such patients.

Detention in Hospital. Under the same Act an inmate of an isolation hospital who is suffering from a notifiable infectious disease may be ordered by a Justice to be detained therein, if on leaving the hospital he would be without proper lodging to prevent the spread of the disease. If he leaves the hospital contrary to the Order he is liable to a fine, and may be taken back.

Death in Hospital. If a person dies in hospital of a notifiable disease and the medical officer of health or other registered medical practitioner certifies that in order to prevent the spread of infection the body should not be removed from the hospital except to a mortuary or for immediate burial or cremation, it is not lawful to remove the body from the hospital except for such a purpose.

Tuberculosis. A person suffering from respiratory tuberculosis who is in an infectious state may be removed to hospital, under like conditions to the above, by the order of a Court of summary jurisdiction and detained therein up to 3 months. Thereafter the Court, on cause shown, may order his detention for a further period or periods, up to 3 months on each occasion. It is permitted to apply for the rescission of a detention order. Under the Tuberculosis Regulations, 1930, no notified case of tuberculosis may be subjected to restriction in respect of his occupation, except that cases of respiratory tuberculosis may not milk cows, treat milk or handle milk vessels.

Procedure similar to the above holds in Scotland under the Public Health (Scotland) Act, 1897, for both removal to hospital and detention, except that no separate provision is made for cases of tuberculosis.

The removal of an infectious case to hospital frees the household and the immediate neighbourhood from the risk of further infection from that source, and is to that extent a clear advantage. With regard to the influence of hospital isolation in the long run on the control of mass infection a more guarded view must be expressed.

If the disease is one with a prostrating onset and typical well-marked symptoms, and if its contagium passes by transmission from case to case without much aid by intermediaries, it is possible by a vigorous isolation policy to impound the sources of infection early and prevent further spread. Isolation in hospital, reinforced by other measures, has rendered good service in the control of smallpox. It has been effective too with pneumonic plague in local outbreaks.

But if the disease, like measles, is markedly infective in its preeruptive stages before it is usually recognised, if as in ambulatory typhoid it assumes atypical forms, if mild cases are common as in scarlet fever, or abortive cases as in poliomyelitis, or if transmission takes place as in diphtheria by carriers as well as cases, or as in cerebrospinal fever by carriers solely or mainly, the isolation of known cases, by the time they come to light, cannot be expected to have more than a limited effect on the general prevalence, since infection is continually flooding on through channels beyond control. Statistical enquiries made in England on a substantial scale confirm this view. They have failed to reveal any general tendency for diphtheria or scarlet fever to be of low prevalence in areas where the proportion of cases removed to hospital has been high.

On the other hand isolation hospitals provide treatment for their inmates which is necessarily often of a more specialised character than can be properly carried out in the average home. Some of the specific infections call for immunotherapy or chemotherapy: some are apt to develop critical complications which demand unceasing vigilance on the part of the nursing staff. Cases of such a disease as pneumonia may be removed to a fever hospital expressly for the treatment which it affords rather than with any view to preventing the spread of infection. Children suffering from measles are often admitted when the most infective stage is over in order that they may be nursed through the dangerous pulmonary complications of that disease. The value of the service rendered to the community by the isolation hospitals in such respects as these can scarcely be overstated.

The problem of cross infection in fever hospital wards has for long engaged the attention of medical officers of health. It appears from recent work that such infections may result from the wafting of germ-laden dust which has accumulated on ward furniture or fittings. Much may be done to diminish the risk by vacuum cleaning walls and floors, by damp-dusting and by spraying floors and furniture with spindle oil.

Isolation Period

Isolation should normally continue until the patient has ceased to be infective. Table 36 sets forth the points for guidance in a number of infectious diseases occurring in this country.

Table 36.

Isolation.

Disease.	Isolation Period.
Cerebrospinal Fever	Till 3 weeks after evening temperature normal.
Scarlet Fever	4 weeks, or till all discharges have ceased.
Diphtheria	4 weeks, or till health restored. Subject to negative cultures and absence of discharges.
Encephalitis Lethargica	Indefinite.
Poliomyelitis	4 weeks.
Whooping Cough	6 weeks, or less if the whoop has ceased.
Measles	15 days from onset, if health restored.
Typhus	5 weeks from onset.
Smallpox	Till last crust has separated.
Typhoid Fever	Till health restored. Subject to negative cultures.
German Measles	7 days from onset.
Chicken Pox	Till lesions have healed.
Mumps	Until 1 week after subsidence of swelling.

QUARANTINE

Quarantine, originally maritime, has been abolished for ships in Britain, and the word has now come to be applied to the period of surveillance within which any person exposed to infection may possibly develop an attack of the disease. In some diseases the duration of quarantine should slightly exceed the incubation period in order to allow for an obscure onset or for early symptoms being concealed by the person in the hope of evading segregation. For households in which infection has occurred, quarantine should be reckoned from the date of disinfection following the removal to hospital or the death of the patient. In the case of principal infectious diseases, such as *Variola* major, persons exposed to infection are kept under surveillance by the staff of the Medical Officer of Health till the quarantine period has expired. Persons under surveillance after exposure to smallpox may inform the inspecting officer that they feel well when the reverse is the case. It should be the routine procedure to take the temperature in all such cases. In cases of minor infectious diseases, which often do not come under official charge, other members of the household who have not had the disease already, if they are engaged in employment or wish for any reason to make arrangements ahead, may ask the practitioner in attendance to name the date by which they may consider themselves ‘safe.’ The quarantine periods shown in the subjoined Table will suggest appropriate answers.

TABLE 37.

Quarantine.

	INCUBATION PERIOD. *Days.*	QUARANTINE PERIOD. *Days.*
Cerebrospinal Fever	1-5	7
Chicken Pox	12-21	—
Diphtheria	2-7	7
Encephalitis Lethargica	2-20	14
German Measles	5-21	—
Measles	7-14	16
Mumps	12-26	—
Poliomyelitis	7-14	14
Scarlet Fever	1-8	8
Smallpox	5-15	21
Typhoid Fever	12-21	21
Typhus	10-14	16
Whooping Cough	7-18	20

CONTACTS

A contact is one who has been in the company of a person suffering from an infectious disease, living in the same house, sleeping in the same bed or dormitory, or working at the same bench, according to the circumstances. Contacts may be sick or well, infected or uninfected, immune or susceptible, and carriers or non-carriers.

A sick contact may prove on examination to be a missed case. He may be the source of infection of the notified case, or both may have been infected from a common source.

Infected contacts will normally develop the disease within the quarantine period, while those who are uninfected will remain well. To contacts with smallpox, measles or diphtheria the appropriate prophylactic inoculum may be administered. If given in time it will avert or moderate any impending attack.

Contacts with smallpox, chicken pox or measles who have had the disease already may be regarded as immune. In most other diseases a previous attack confers some protection, ranging from slight to considerable. Where a contact has not already passed through an attack we have as a rule no means of determining whether he is immune or susceptible. In diphtheria, however, the Schick test and in scarlet fever the Dick test may help us to decide.

Smallpox contacts, under the Smallpox Prevention Regulations, 1917, may be vaccinated or re-vaccinated free of charge by the Medical Officer of Health, subject to their consent. Recent typhus and relapsing fever contacts may, under the Infectious Diseases Regulations, 1927, be temporarily segregated and steps taken to free them and their clothing from lice. Child contacts may be excluded from school attendance by the Medical Officer of Health as already noted.

In Scotland, arrangements similar to the above hold with reference to contacts, and in addition the Medical Officer of Health, under the Public Health (Scotland) Act, 1897, may examine contacts in a house where infectious disease is believed to exist or has occurred.

CARRIERS

Some contacts on bacteriological examination may prove to be carriers. The significance of the carrier state has already been discussed.

The Infectious Diseases Regulations, 1927, seek to provide against the infection of food by enteric fever and dysentery carriers.

If the Medical Officer of Health suspects that a person who is employed in preparing or handling food for human consumption is a carrier of either enteric fever or dysentery, he must report to his local authority who may in writing notify the manager of the business that the person must be medically examined, and the manager must render all reasonable assistance. If from the medical examination or a bacteriological or protozoological examination or otherwise the Medical Officer is satisfied that the person is a carrier of enteric fever or dysentery he must again report to his local authority, who may then in writing notify the manager, and also the person, that the person is a carrier, with a view to preventing for a specified period the employment of the person in the business or in any other business of the same kind.

In Scotland under the Infectious Diseases Regulations (Scotland), 1932, a carrier means a person who has within himself the germs or other infective virus of an infectious disease but has no other sign or symptom thereof, and who is certified by the Medical Officer of Health and one other medical practitioner to be a danger to others. While so certified, the person comes under all the restrictions which apply to a case of infectious disease. The certificate holds for three months but is renewable for three-monthly periods. If it is not renewed, or if it is cancelled by the Department of Health on an appeal by the person, he goes free.

It should be remembered that not all carriers are dangerous, and that it is possible to be over-energetic in their control.

IMMUNOPROPHYLAXIS

Immunoprophylaxis may be employed either in emergency for the protection of contacts or other persons who may already be infected with a disease, or as a general precautionary measure against the contingent risk of a subsequent exposure.

Under emergency conditions, smallpox contacts may be actively immunised by vaccination, which if carried out soon enough[1] after the exposure will avert the impending attack. Diphtheria contacts may be passively immunised with diphtheria antitoxin, and measles contacts, as already noted, by giving them convalescent antiserum. In cases of gunshot or other deep wounds tetanus antiserum has had a high protective value, both in war and peace.

As a general precaution taken in advance, active immunity may be induced in persons proposing to enter an infective environment, for example, people going abroad from this country, who may be inoculated with the T.A.B. vaccine against the typhoid fevers and with the virus vaccines against typhus and yellow fever respectively. Active immunity may be induced also in nurses taking up duty in a smallpox hospital or a diphtheria ward, the former of whom should be vaccinated, and the latter immunised with diphtheria toxoid. The same kind of precaution may be applied in Britain against the general risk from an endemic infection, as when the boys in a residential school are actively immunised against diphtheria, or on a community basis when the effort is made to immunise all pre-school and school children against this disease. Infantile vaccination, as authorised by law, is another instance of community immunisation. In the case of a town which is faced with a rising epidemic of smallpox, vaccination or revaccination may be offered free of charge to all who are willing to undergo it.

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[1] Page 490.

When undertaking community immunisation against diphtheria or whooping cough, it is useful to explain to parents and others that the full course of injections must be taken before protection can be expected, and that some six to eight weeks will elapse following the final injection before immunity is established. Children exposed to infection before they are fully protected may develop the disease, but usually escape with a mild attack. Fatality in immunised cases is rare. It is nowadays the practice to offer combined immunisation against diphtheria and tetanus or typhoid and tetanus.

DISINFECTION

The purpose of disinfection is to abolish any infective power of material in or upon which pathogenic micro-organisms have lodged. It need not go as far as sterilisation, which would mean the extinction of all life, including bacterial spores: but it goes further than antisepsis which is the prevention or retardation of bacterial growth. Disinfection may be carried out by means of chemical disinfectants, or by steam or dry heat. Other methods are burning and boiling.

DISINFECTANTS

The efficiency of a chemical disinfectant in aqueous solution may be expressed in terms of its phenol coefficient. In the Rideal Walker test the sterilising power of dilutions of the disinfectant upon a known strain of *B. typhosus* are compared with that of a dilution of pure phenol under the same conditions. If a 1 in 900 dilution of the disinfectant kills the strain in the same time as a 1 in 90 dilution of phenol, the phenol coefficient of the disinfectant is 900 ÷ 90 = 10, phenol being taken as 1. The 'inhibition coefficient' is the lowest percentage concentration of an antiseptic which will completely inhibit bacterial growth. The 'inferior lethal coefficient' is for bacteria. The 'superior lethal coefficient' is for spores.

The Martin-Chick modification of the Rideal Walker procedure seeks to make allowance for the conditions under which a disinfectant will normally operate by adding sterile powdered faeces to the disinfectant dilutions under test.

A disinfectant, besides possessing a high phenol coefficient, should mix readily with water, and remain in solution or suspension. It should not corrode metals or damage fabrics. Its potency should not be greatly reduced in the presence of organic matter. It should not be too toxic to the higher animals. A disinfectant must be allowed time to act, especially if the bacteria, for any reason, are secluded from access. It has been found that emulsions in general are more effective than solutions.

Soap. Domestic soap, either hard or soft, is an adequate disinfectant for many purposes. A scrubbing-brush charged with soap and water will remove pathogenic organisms from floors or similar surfaces. Boiling in soap and water will destroy bacteria in textiles. Prolonged soakage at lower temperatures may be equally successful.

Cresol. Commercial cresol is a mixture of *o*-, *m*- and *p*-cresol or hydroxytoluene, $C_6H_4.CH_3.OH$. It is a liquid substance and less toxic to man than phenol. It emulsifies readily and in that kinetic state is actively germicidal. The official preparation is Liquor Cresolis Saponatus. Well-known cresol emulsions are Lysol, Izal, Cyllin and Monsol. Lysol, which contains toxic derivatives, has a phenol coefficient of 5 to 10 : it is used in a dilution of 1 per cent. Izal and Cyllin have a phenol coefficient of 20 and are used in dilutions of ½ per cent.

Phenol. Pure phenol or hydroxybenzene, C_6H_5OH, though weaker than cresol and crude carbolic acid, is a useful disinfectant. It may be employed in dilutions of 1 in 20 upwards. In common with cresol and crude carbolic acid it has little effect upon the smallpox virus.

Carbolic Acid. Crude carbolic acid contains phenol, the isomeric cresols and other substances. It does not attack metals or destroy textiles, though it may mark the latter. It may be used in a dilution of 1 in 20. Its phenol coefficient is raised by the cresols which it contains to 2·75 or thereby.

Dettol, a member of the chlorinated phenol series, is the halogen derivative of xylenol, put up with aromatic essential oils. It is readily miscible with water and is bland even in high concentrations. Its action is not retarded by the presence of pus. In dilutions of 1 per cent. it is lethal to *Streptococcus pyogenes.* Its homologue Dettolin is suitable for internal use.

Mercuric Chloride, $HgCl_2$, has a high germicidal potency. In a dilution of 1 in 1000 it kills non-sporing bacteria in 30 minutes, and in 1 in 500 destroys spores in an hour. It is impaired in efficiency by the presence of organic matter, especially in alkaline fluids. It corrodes metals and is precipitated by sulphides. Mercuric chloride makes up well in sea water or with hydrochloric acid. Its solutions, owing to their poisonous character, should be coloured with anilin blue or other warning dye. The formula $HgCl_2$ ½ ounce : HCl 1 ounce : anilin blue 5 grains to water 3 gallons, gives a strength of approximately 1 in 1000. The so-called biniodide of mercury is the double iodide of mercury and potassium. It is more potent and less toxic than the perchloride. It does not corrode instruments and is active in soapy solutions.

Lime, CaO, is a good and cheap disinfectant. Combining with water in the proportion of 2 lbs. of lime to the pint of water it forms *Slaked Lime*, $Ca(OH)_2$. A 3 per cent. solution of slaked lime kills *B. typhosus* in an hour. *Whitewash* is slaked lime mixed with water: it is good for the walls of cellars, stables and outbuildings. *Milk of Lime* is slaked lime in 4 to 8 times its volume of water: it may be used for privies. *Bleaching Powder* or chlorinated lime, which has the approximate formula $Ca(OH)_2\ 2Ca(OCl)Cl$, is prepared by passing nascent chlorine over moist $Ca(OH)_2$. It contains approximately 33 per cent of available chorine while fresh. It is on this account desirable to purchase bleaching powder in hermetically sealed tins, as exemplified by 'Stabochlor' (I.C.I.). In 1 per cent. strength in water it kills most bacteria within 5 minutes. In 5 per cent. strength it destroys spores within an hour. Bleaching powder solutions are damaging to fabrics.

Chlorine Derivatives include Dakin's solution and Eusol. The proprietary compounds Milton and Parozone are similar hypochlorite solutions prepared electrolytically. Their antiseptic action depends upon the liberation of hypochlorous acid. They are in addition powerful deodorants and as such are of value in wound irrigation. Dakin's solution and eusol should be freshly prepared for use. Milton and parozone are claimed to be more stable. They have a rôle in the domestic purification of drinking water.

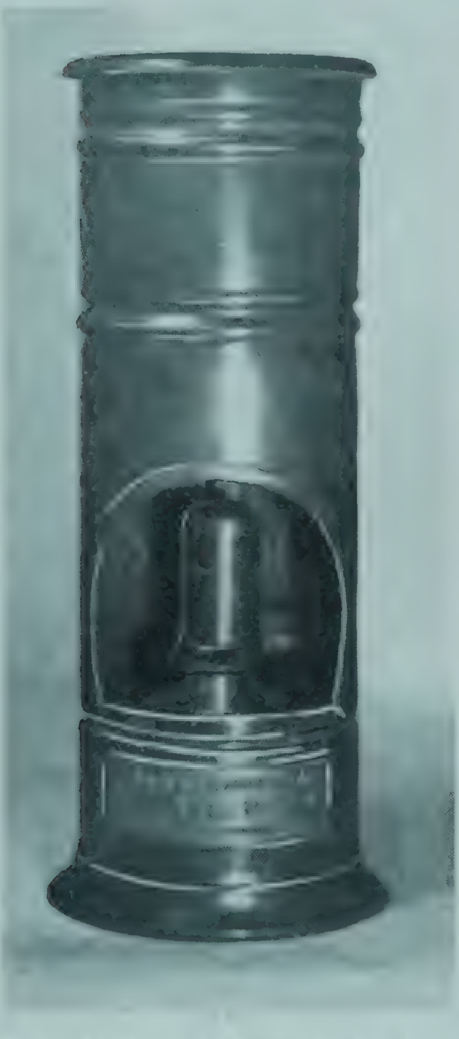

Fig. 102.—Alformant lamp.

Formaldehyde, HCHO, which is gaseous, is of service for the disinfection of sick rooms and their contents. It is actively germicidal but weak against insects, which elude it in recesses. It does not tarnish metals or injure textiles. A room the surfaces or contents of which are proposed to be treated with formaldehyde should be sealed by pasting stout paper over its chinks and orifices. It should be at a temperature of 60° to 70° F. and should have a relative humidity of 60 to 70 per cent. It should remain closed, exposed to the action of the gas, for 6 hours. The gas may be set free in the room by volatilising tablets of 'paraform' over a special lamp (Fig. 102), allowing, say, 30 1-gram tablets per 1000 cubic feet of space. Or else it may be generated by the action of formalin on compressed tablets of potassium permanganate in an iron bucket with flaring top, set on bricks or other supports to protect the floor from the heat developed. The quantities required are 5 ounces of $K_2Mn_2O_8$ to 15 ounces of formalin for each 1000 cubic feet of space. Formaldehyde can be applied also, in a formaldehyde chamber, to the disinfection of blankets, footwear, toys and other articles which will not stand steam disinfection.

Formalin is a 40 per cent. aqueous solution of formaldehyde. It deteriorates in open vessels, and on exposure to cold precipitates its

HCHO as paraformaldehyde, $(CH_2O)_6.H_2O$, the 'paraform' of the preceding paragraph. The activity of formalin, which is about half that of phenol, is not greatly impaired by the presence of organic matter. According to the object in view formalin may be used in dilutions of 2 to 10 per cent., representing 0·8 to 4 per cent. of formaldehyde. In the spray method of disinfection, a solution of formalin in the strength of 6 to 8 ounces per gallon of water, with 5 per cent. of glycerin added to delay drying, may be applied by means of the Mackenzie spray (Fig. 103), or equivalent apparatus. One gallon of water so charged would suffice to disinfect 400 square feet of wall surface.

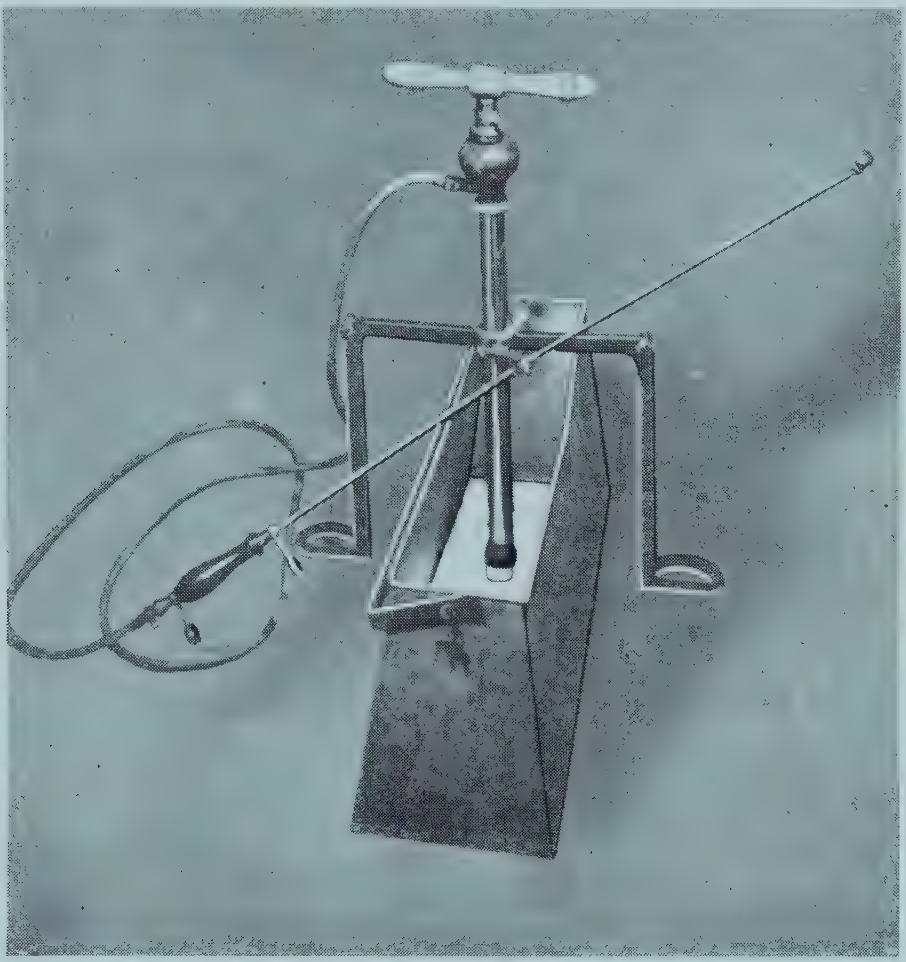

Fig. 103.—Mackenzie Spray.

Sulphur Dioxide. This gas is a feeble germicide, though useful against insects and rats.[1] Crushed Sicilian roll sulphur is placed in an iron pot standing in water, soaked with alcohol or paraffin and ignited. The heat of the open burning helps to diffuse the heavy gas. Three pounds of sulphur may be burned per 1000 cubic feet of space and 6 hours' exposure given. Two 20-ounce cylinders of the gas liquefied under pressure will give an equivalent concentration. The 'Sulphume' apparatus of Messrs. Boake and Roberts, Liverpool, for domestic use, is a thin metal cylinder containing liquid sulphur dioxide which is liberated in gaseous form when the seal is broken by cutting with a pocket knife. Fabrics are bleached, and bright metals tarnished by SO_2.

STEAM HEAT

The high value of steam as a disinfectant depends on the power which it possesses to penetrate textiles and similar materials. Coming in touch with such fabrics the steam condenses into water, shrinking in the process to 0·0006 of its former volume. A low-pressure region is thus formed into which more steam presses, to condense and shrink in its turn, till penetration is complete. The steam in condensing surrenders its latent heat of vaporisation, which is 536·5 calories per gram of water condensed.

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[1] Page 580.

Steam which is ready to condense is at its saturation temperature, being in contact with the water surface from which it is given off. When superheated, that is to say, raised above its saturation temperature, it loses its penetrating power and is no better than hot air. Current steam and pressure steam, noted below, are both applications of saturated steam.

Current Steam, which is at or near atmospheric pressure, moves freely through the disinfecting chamber displacing air in its passage. The method is comparatively inexpensive and simple to work, though rather slow. The horizontal *Thresh* disinfector consists of a metal disinfecting chamber enclosed by a steam jacket. The lower part of the jacket, which forms the boiler, contains water charged with calcium chloride. This solution boils at 220° F. While the disinfection of articles is in progress steam passes continuously through the jacket and chamber. When disinfection is complete steam is shut off from the chamber, and hot air is drawn through to hasten drying. Colonel Lelean's vertical *Sack* disinfector is portable and convenient. The fabrics to be disinfected are hung in a steam-proof sack, into the top of which steam is led from a small oil-fired boiler. The sack becomes filled with live steam which kills non-sporing bacteria. The *Serbian Barrel* is an improvised current steam disinfector favoured by the Army. The steam, raised in a five-gallon oil drum, is led through the top end of a barrel set vertically, from which it escapes by perforations underneath. The barrel is usually lagged with earth in order to conserve the heat. Disinfected clothing is dried in air after its removal from the barrel.

Pressure Steam is imprisoned, not free. Disinfectors of the pressure type require to be of strong construction. They are costlier and more complex than current steam plant. The horizontal *Washington Lyon* machine is equipped with a separate boiler. The steam-jacketed metal disinfecting chamber, which is oval shaped, has a hinged access door at either end, and contains a cradle on which the articles to be disinfected are laid or hung. When the cradle with its load has been run through one of the access doors into the disinfecting chamber on the rails provided both doors are shut and clamped tight. Steam round 20 lbs. pressure and 250° F. is passed into the jacket to heat the inner surface of the chamber and so prevent condensation. This done, air is exhausted from the chamber by blowing steam across an orifice. Then steam is passed into the chamber—which contains the articles to be disinfected—and pressure is held round 20 lbs. for 20 minutes. The disinfected articles are dried by drawing hot air through the chamber. A small auxiliary fitting enables formalin to be mixed with the entering hot air if desired. The articles are finally removed from the chamber by running the cradle, which carries them, out through the opposite door to the one it went in by.

It is essential that the inside of bundles undergoing steam disinfection should reach germicidal temperatures. This may be ascertained by means of a maximum thermometer placed inside a bundle, or with a thermocouple connected up with a warning signal or recording drum. Evidence of efficient working may be secured also by placing gauze charged with suitable bacteria inside a bundle. If the gauze after exposure yields no bacterial growth in media, disinfection of the bundle and of other articles in the chamber should have taken place.

Disinfecting Stations (Fig. 104) consists of two compartments completely separated by a dividing wall with fixed observation window. The Washington Lyon or other disinfector is so built into the dividing wall as to have one end, and therefore one door, in each compartment. To the charging end infected articles are delivered in an 'infected' van: from the discharging end the disinfected articles are loaded into a 'clean' van and returned whence they came. The lighting and ventilation of both compartments should be above criticism. Plant for disinfection, including disinfestation, should be attached to a sanitary wash-house or cleansing station for verminous school children or other verminous persons. It is a necessary equipment for reception houses in which temporary accommodation is provided for contacts pending the disinfection or disinfestation of their persons, clothing or dwellings.

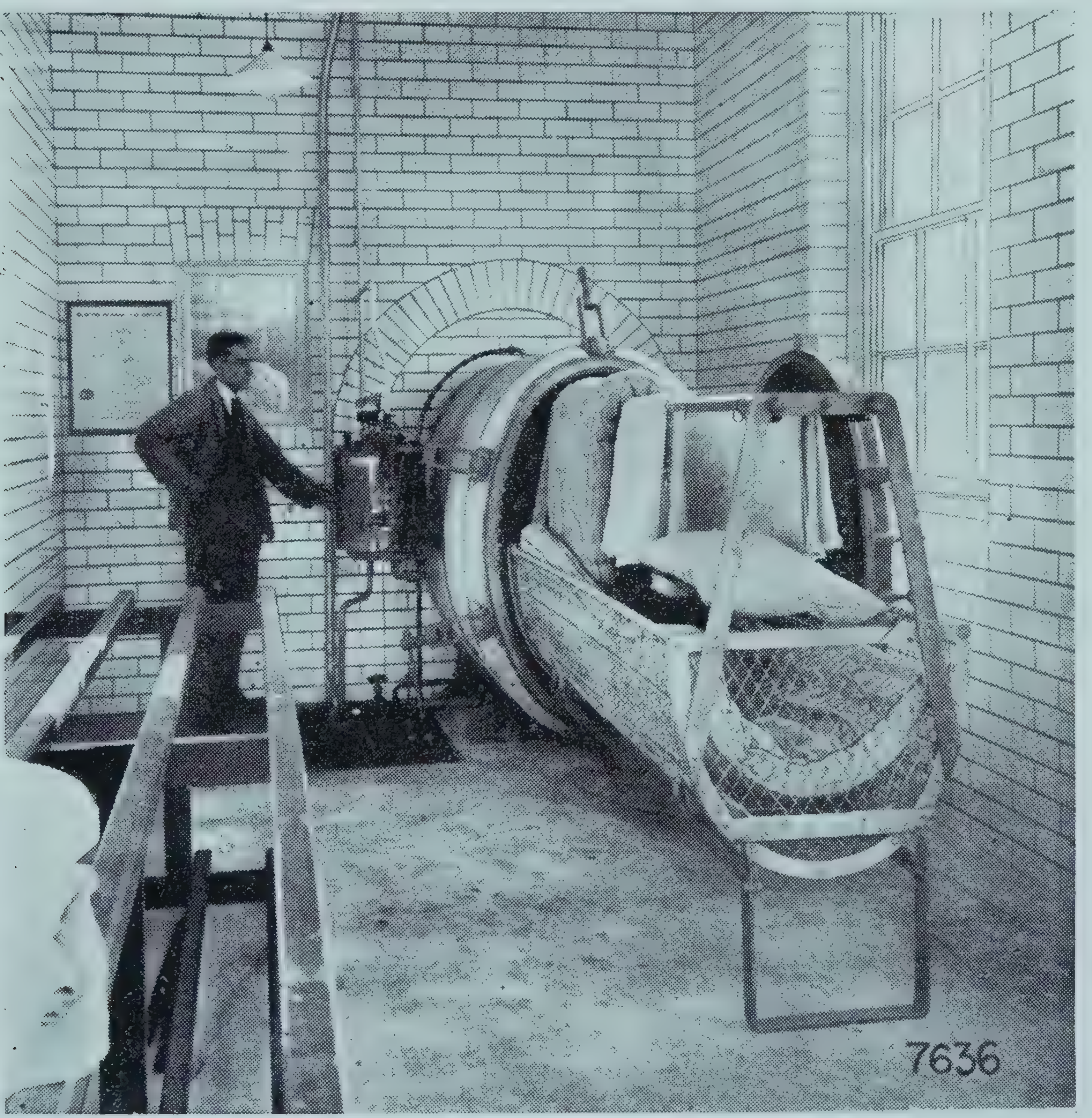

Fig. 104.—Disinfecting Station, showing Steam Disinfector with cradle drawn out.

DRY HEAT

Dry heat is successfully employed in the British Army for the disinfestation of uniforms, clothing and equipment. It is however less satisfactory as a bactericidal agent. The 'Millbank' transportable disinfestor consists of two double-walled canvas compartments erected on a steel frame and fitted with metal racks to carry the articles requiring treatment. Hot air, generated by petrol burners and propelled and circulated by a petrol-driven fan, is forced into the compartments where it may reach a temperature of 150° C. within fifteen minutes. Half an hour's exposure to the hot air is sufficient for most purposes.

OTHER METHODS

Infective discharges may be destroyed by burning in a fire or furnace. Infective articles of little value may be similarly disposed of. Boiling is good for the disinfection of infective textiles, as non-sporing bacteria are killed at once. Blankets and other woollens, however, should not be boiled.

CONCURRENT DISINFECTION

During the nursing of cases of infectious disease it is essential to prevent the transmission of infection to the medical attendant and nurses, or at longer range to other persons. With most diseases the danger zone is the immediate neighbourhood of the patient: with some, such as typhoid fever, infection may be conveyed also to a distance owing to the presence of discharges which may gain access to food or water supplies. The steps taken should be adjusted so as to bar the particular path of infection: on this the value of isolation as a means for the control of infectious disease largely depends. Disinfection which is thus carried on during the course of a patient's illness is concurrent, or routine, disinfection. It forms an essential part of the sick-room or ward routine for all infectious cases. For example:

Nurses' hands should be immersed in phenol solution 1 in 40, or $HgCl_2$ 1 in 2000.

Clinical thermometers should be kept in phenol solution 1 in 20.

Feeding equipment should be boiled or scalded.

Remains of food should be destroyed by burning.

Nasal, faucial and ear discharges or secretions should be taken up in gauze swabs and destroyed by burning.

Sputum should be received in gauze swabs or paper sputum cups and destroyed by burning. If, as in tuberculosis hospitals, the total quantity of sputum is large it should be mixed with phenol solution 1 in 20 and allowed to stand for 2 hours before disposal to a drain, or else placed in a sputum sterilising autoclave and held round 20 lbs. for 20 minutes.

Faeces. (*a*) Mix with an equal volume of phenol solution 1 in 20, stir and comminute with a wood splinter and allow to stand for 2 hours before disposal to a drain. Or (*b*) cover with bleaching powder, add water, stir and comminute with a wood splinter and allow to stand for 2 hours. Then bury: do not discharge to a drain. Or (*c*) cover with hot water at 130° to 140° F., add one large cupful of quick lime, disintegrate and allow to stand for 2 hours. Then bury: do not discharge to a drain. Or (*d*) sterilise in a special steam steriliser.

Urine should be treated with phenol solution 1 in 20 and allowed to stand for half an hour.

Textiles, if soiled with excreta or discharges likely to be fixed by heat or antiseptics, should be treated first with soft soap 3 per cent. solution at 120° F. for 3 hours, and left to soak, after cooling, for 48 hours. Thereafter, except blankets and woollens, they may, if desired, be boiled. If large, they may be either (*a*) soaked in carbolic acid solution 1 in 20 for 12 hours, or (*b*) boiled, or (*c*) dispatched to a steam disinfector.

Blankets and other woollens should not be boiled or subjected to steam heat. After preliminary treatment as above, if necessary, to prevent fixation of discharges, they may be either (*a*) soaked in carbolic acid solution 1 in 20 for 12 hours, or (*b*) sprayed with formalin, or (*c*) treated with formaldehyde in a formaldehyde chamber.

Floor and wall surfaces which are accessible should be kept clean up to the best domestic standards.

TERMINAL DISINFECTION

On the termination of a case of infectious disease in a house, owing to the recovery or death of the patient or his removal to hospital, elaborate disinfection is often superfluous, and the practice has been abandoned in a number of towns in this country and abroad without ill results. With many diseases the risk of infection automatically ceases when the sick room is vacated: with others, if concurrent disinfection has been attended to, there is little or nothing left which calls for further action.

In many cases therefore it may be enough to wash the bed- and body-clothing and clean the sick room, scrubbing the floor with soap and water, damp-dusting paint and woodwork and applying dry methods to other surfaces. The windows should be opened wide so as to let in fresh air and sunlight, which are natural disinfecting agents.

In dealing with smallpox, however, or other major infections, and also in certain cases where concurrent disinfection may not have been carried out, it is proper that terminal disinfection should be undertaken. Blankets and other textiles should be managed as in concurrent disinfection or treated with formaldehyde or the formalin spray. The mattress, if worn out, should be incinerated in a destructor: if serviceable, it should be sent away for steam disinfection, or treated with formaldehyde or the formalin spray. Wearing apparel and footgear should be treated with formaldehyde or the formalin spray. Books and children's toys, if valueless, should be burned: if valued, they may be exposed in a closed cupboard to formaldehyde gas. Books in general are not apt to convey infection. The sick room should be prepared for disinfection by drawing furniture out from the walls and leaving drawers and cupboards open. It should be sealed[1] and then treated with formaldehyde or the formalin spray. Any of the articles mentioned above as suitable for formaldehyde or formalin treatment, may, if desired, be set out in the sick room before the disinfection begins and disinfected along with the room.

Whatever discretion may be permissible with regard to the use of terminal disinfection in dealing with the common infections, if the disease is one conveyed by ectoparasitic or house-haunting insects a terminal disinfestation[1] is proper in all cases.

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[1] Page 428.

Under the Public Health Act, 1936, a local authority may provide a disinfecting station and may cause articles brought there to be disinfected free of charge. A local authority under prescribed conditions may notify the owner of an infected house that they will disinfect it unless he does so, and in his default may themselves carry out the work and recover expenses: in certain cases they may carry out the work at their own cost. Compensation is payable by the local authority for any damage done. A local authority may provide a temporary shelter, usually called a reception house, for any occupant of a house which requires to be disinfected. It is a penal offence to let a house in which a person has been suffering from a notifiable disease without having it disinfected to the satisfaction of the Medical Officer of Health or some other registered medical practitioner. It is a penal offence under similar conditions to allow the occupation of a room in a hotel or inn. It is a penal offence also to cease to occupy a house in which a person has within six weeks previously been suffering from a notifiable disease without having it disinfected to the satisfaction of the Medical Officer of Health or some other registered medical practitioner. Requirements as to the disinfection of articles have already been noted.

In Scotland provisions equivalent to the above are made under the Public Health (Scotland) Act, 1897.

AIR DISINFECTION

Experiments in the disinfection of air by ultra-violet irradiation have yielded satisfactory results. The methods used appear to work best when the micro-organisms are attached to dust in a fine state of division. Larger particles, if present, may form a protective shield.

The use of spray-produced bactericidal mists or 'aerosols' has lately been recommended for hospital wards, schools, air-raid shelters and other confined spaces. Among the reagents which have been employed are hexylresorcinol, tri-ethylene glycol, chloramin-T (p-toluene-sodium-sulphochloramide), catechol and sodium hypochlorite. The last, in 1 per cent. solution, was 95 per cent. efficient against air-borne streptococci. The vaporisation of propylene glycol over a low flame has produced a substantial reduction in the bacterial flora of the air in rooms. A fairly high concentration of the vapour must be maintained. Its generation therefore has to be continuous. Reference has already been made to the use of ultra-violet radiation in prematurity wards.[2]

DISPOSAL OF THE DEAD

Earth Burial is the time honoured method for the disposal of the dead in Britain. Sentiment clings to the country churchyards which have at least inspired one distinguished poem, and proof that they have been damaging to health is on the whole wanting. In cities, when old burial places have received their full complement of interments, it is often difficult to secure new sites of adequate size within a convenient distance. The practice of overcrowding intramural burying grounds should however be discouraged. It is estimated that from a quarter to half an acre of land is required for burial per 1000 of population for 14 years. The best soil for a cemetery is a sandy loam. Loose gravel, stiff clay and chalk are unsuitable. The graves should be clear of the ground water level by several feet.

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[1] Pages 429, 431.

[2] Page 31.

Under the Burial Acts, any local authority may, and if required by the Minister must, provide a cemetery for their area. The cemetery must have walls or railings at least 8 feet high and must be adequately drained. Graves are required to be separated by at least 1 foot of ground. The grave spaces prescribed are: for persons above 12 years of age, 9 feet by 4 feet: for persons under 12 years of age, 6 feet by 3 feet, or 4½ feet by 4 feet. Regulations made under the Burial Acts forbid the opening of the grave of a person under twelve within 8 years, and of a person over twelve within 14 years, for the purpose of burying therein the body of a person not a member of the family. In the case of a person under twelve, every part of the coffin must be at least 3 feet, and in the case of a person over twelve, at least 4 feet below the level of the adjoining ground. Where there is more than one coffin in a grave they must be separated from one another by at least one foot of earth closely rammed down. There must be at least one foot of earth above the last coffin to be interred.

'Surface' burial, employing perishable coffins of paper pulp, or millboard in shallow soil has lately been suggested. A rapid dissolution of the body is claimed from this method.

Cremation, or the burning of the dead, was customary in ancient Greece and Rome. Any sentiment which gathers round it is therefore pagan. The modern crematorium reduces the body to some 3 lbs. of ash within two hours. The ashes may either be sealed in an urn and given into the charge of a relative or placed in the columbarium, or if so desired may be scattered in a Garden of Remembrance at the Crematorium. Cremation as a method of quick disposal and one which withdraws little land from other uses is to be commended: it is inexpensive: and its efficiency in the destruction of infection is obvious. The practice is deservedly gaining ground throughout Britain in which there are now upwards of fifty crematoria which together deal with many thousands of cremations annually: much attention is now paid by British architects to the design of modern crematoria, and the skill of the landscape gardener is invariably reflected in their surroundings. A substantial objection to cremation is that it may destroy the evidences of crime. To meet this risk, the Regulations, 1903, made by the Home Secretary in terms of the Cremation Act, 1902, prescribe minutely the conditions under which cremations may take place. It is unlawful to cremate unidentified remains, or the body of any person who has left written instructions to the contrary. Prior to cremation the Regulations require: registration of death unless a coroner has given a certificate:

application made and declaration signed by an executor or nearest relative: special certificate from the practitioner in attendance, confirmed by a certificate from a specially appointed medical referee, or a registered medical practitioner of not less than five years' standing. This confirmatory certificate is not required if there has been a *post mortem* examination by a pathologist, or if an inquest has been held. The medical referee is responsible for seeing that all is in order. He may, without formalities, permit the cremation of the remains of a still born child if certified by a medical practitioner, and if the still birth has been registered.

Under the Cremation Act, any local authority maintaining a cemetery may provide and maintain a crematorium. No crematorium may be constructed within 200 yards of a dwelling house, unless with the consent of owner and occupier, or within 50 yards of a public highway.

XIX.

COMMUNITY DISEASES

Actinomycosis

This chronic infection by the ray fungus, *Streptothrix actinomyces* or *Discomyces bovis* occurs in cattle in all parts of the world, less commonly in horses and pigs, and from time to time in man. The lesion in cattle is a granuloma, appearing as 'lumpy jaw' and 'wooden tongue.' In man the tendency is to a spreading, though generally painless, suppuration which may involve almost any part of the body but most commonly occurs in the head and neck. A fatal pulmonary form of the disease is known, and metastatic lesions are not unusual. Diagnosis is established by the demonstration of mycelial elements in stained films of pus from the lesions. The treatment of the condition is mainly surgical, but striking results are now claimed from the use of penicillin. Sulphathiazole in large doses is also recommended. For preventive purposes the inspection of cattle and of carcases at abattoirs is important. Grooms and cattlemen should be made aware of the risks which they run from infected animals and should receive treatment for any carious teeth.

Allied species of the ray fungus, notably *D. madurae* and *D. asteroides,* are responsible for Madura Foot, which occurs in India and Ceylon and is characterised by swelling, sinus formation and peroneal atrophy.

Beriberi

This disease has been ascribed to the use of a diet deficent in vitamin B_1. It is found among persons subsisting mainly on milled rice. Bacterial action has been suggested as a contributory factor. Beriberi is well known in Malaya, Japan, China, the Philippines, India and Africa. It occasionally visits mental hospitals in temperate climates.

The characteristic peripheral neuritis of beriberi is attended by anaesthesia, muscular wasting, ataxia and ankle drop, together with palpitation pointing to dilatation of the right heart. Anasarca develops later, producing the so-called 'wet' beriberi. Infantile beriberi is a fatal malady of the infants of mothers who are either cases of the disease or are on a beriberi-provocative diet. Case mortality ranges from 6 to 30 per cent.

The treatment of the condition proceeds on dietetic lines. Milled grains should be avoided and replaced by a liberal diet, including vitamin B_1 for the provision of which marmite is recommended. Good results have followed the injection of thiamin hydrochloride. The same dietetic measures are prophylactic. It is wise to check overcrowding, and to remove ill-housed coolie workers to dry quarters in hill country.

Bornholm Disease

This affection, apparently due to a virus, is marked by the sudden onset of severe myalgia, mainly of the pectoral and abdominal muscles, including the diaphragm, together with mild pyrexia. The disease, which may simulate acute abdomen, or pleurisy, has on occasion assumed epidemic prevalence in this country and in Scandinavia. The incubation period is 3 to 4 days, and spontaneous recovery, often attended by profuse sweating, generally occurs within a week. A recent outbreak is reported from Halesowen.

Cancer

The term Cancer as employed in statistical returns usually includes all forms of malignant cytoma, whether the growth originates from epithelial cells or connective or other tissue. The disease affects all races of mankind and all classes and walks of life. There is no adequate evidence that it is hereditary or that it can be contracted by residence in particular districts. It does not appear to be related to the use of diets including flesh. If it were so, persons abstaining from flesh foods would, comparatively at least, be cancer free, but enquiry elicits that members of two great religious houses to whom flesh is forbidden have not enjoyed any special exemption from the disease. Experimentally it has been found easy to produce cancer in certain animals, and cancerous tumours, when transplanted between animals of the same species, may continue to grow. Senescence of tissue is regarded by some as the ruling aetological factor, but no hypothesis so far put forward has met with general acceptance.

While the essential nature of the carcinogenic process remains an unsolved problem, data are nevertheless available with regard to the predisposing causes. Trauma of the cervix at labour appears to act as a source of uterine cancer in later life. Epitheliomatous ulceration is prone to occur in trades where the workers are exposed to irritating substances such as mineral oils, tar and aniline. A non-industrial instance of the effect of irritation is tongue carcinoma from a rough tooth or ill-fitting denture, especially in the presence of syphilitic leukoplakia. In the human subject a long lapse, often of years, may intervene between exposure to the carinogenic irritant and the manifestation of the resulting malignant disease. This protracted latent period has to do with the late age incidence of the disease, which is mainly one of middle life and later, some 90 per cent. of the deaths occurring in persons over 40.

Records show a steadily increasing cancer mortality in England and Wales. Round 1851 the cancer death rate was 0·31 per thousand: by 1921 it had risen to 1·21 per thousand: in 1935 it was 1·58 per thousand, and in 1942 it was 1·69 per thousand. A substantial proportion of the increase may be accounted for by the ageing of the population, as a result of which greater numbers are alive at the ages when death from cancer is most common. A further substantial proportion may be ascribed to progress made in the accuracy of procedures for obtaining evidence of malignancy, for example, in the case of the prostate gland a wider appreciation of the necessity to examine serial sections. But when all concessions have been made, there is much that cannot be explained away, and the increase of tongue cancer in men and mammary cancer in women is believed to represent a genuine extension of the disease in these situations. The fact that uterine cancer has not increased in proportion may be a result of the declining birth rate.

In our present ignorance of the aetiology of cancer there can be no specific prophylaxis. Treatment consists in the removal of the malignant growth by a surgical operation with or without post-operative x-radiation, or with the aid of radium. For many cancers of the female genitalia radium is to be preferred: also for rodent ulcer and facial cancer. All other operable cancers, including those of the tongue, should be treated by surgical operation, using the diathermy knife as a check on dissemination. For all inoperable cancers radium is the approved agent. Deep x-ray therapy is employed in certain cases, to alleviate rather than to cure: its use involves blood-vascular risks. Combinations of the various methods may be put into practice. Good results have been claimed from oestrogens, such as stilboestrol, and from the anti-biotic concentrate H_{11}, but these substances are still on trial. All treatment should be given at the earliest possible stage of the disease.

Early suspicion by a person that some symptom of his may mean cancer, and early recognition by the doctor he consults that cancer is present or possible, are the prerequisites for the early treatment which may effect a cure. To these ends a judicious propaganda telling the people what they need to know will greatly help. If conducted with a heavy hand it may cause much unhappiness. ‘The Truth About Cancer’ issued by the British Empire Cancer Campaign says the right thing in the right way.

Another helpful agency is the cancer diagnostic clinic where patients are seen free of charge by a medical officer. If the growth is non-malignant the patient is referred to his own doctor. If it is malignant or suspected of malignancy he is sent for examination to a specialist whose fee is paid by the local authority. If malignancy is confirmed by the specialist, steps are at once taken to secure the patient’s admission to hospital or to provide other appropriate treatment.

Serological tests for the early diagnosis of cancer, as proposed by Bendien and other observers, have not proved reliable.

The Cancer Act of 1939, not yet in effective operation, applies to the United Kingdom but excludes Northern Ireland. It requires local authorities to make facilities and machinery available for the early diagnosis and treatment of cancer. It provides for Exchequer grants towards the cost of such schemes, including loans to the National Radium Trust. Further, it makes it an offence to ‘publish advertisements offering to treat, or prescribe treatment for, cancer.’

Cerebrospinal Fever

First described by Vieusseux at Geneva in 1805, cerebrospinal fever has shown recurrent periods of prevalence, beginning in 1805, 1837, 1854, 1876, 1893 and 1906 respectively. From 1914 to 1918 there were 1892 deaths of British soldiers in the United Kingdom from this disease.

The fever is characterised by nuchal rigidity, or else retraction of the head which may amount to opisthotonus, together with a petechial eruption and herpes of the lips. Kernig's sign is almost invariably present. There is usually severe headache and there is nearly always increased sensitivity to cold. In the chronic type of the infection wasting may be extreme, and is usually accompanied by progressive hydrocephalus and mental impairment. The complications of the fever include facial and other paralyses, blindness and loss of hearing. It should be kept in mind that cerebrospinal fever may also occur without the classical symptoms.

The disease is for the most part one of temperate climates, appearing mainly in late winter and spring, though outbreaks have occurred in the tropics also. It principally attacks children under ten, adolescent and young adult ages. Its severity on occasion may be extreme, cases dying within 24 hours of onset. The sick, who require expert nursing, should be removed to hospital.

The introduction of chemotherapy has markedly decreased the fatality from cerebrospinal fever and a case mortality as low as 5 per cent. is not now regarded as unattainable.

The specific bacterium is the Meningococcus (*Neisseria intracellularis*), of which several serological types are known. The organism is found on lumbar puncture in the cerebrospinal fluid. It is usually present in the naso-pharynx and may also occur in the blood. The cerebrospinal fluid may be turbid or purulent and is always under pressure. Specimens of it should be microscopically examined immediately on withdrawal, as the meningococci tend to autolyse and on that account may be missed. The protein content of the fluid is markedly increased, the sugar diminished or absent, and polymorphonuclear leucocytes present in excess. Where the fluid obtained by lumbar puncture appears normal although the symptoms point to cerebrospinal fever, the case may be one of encysted meningitis and cisternal puncture should be performed.

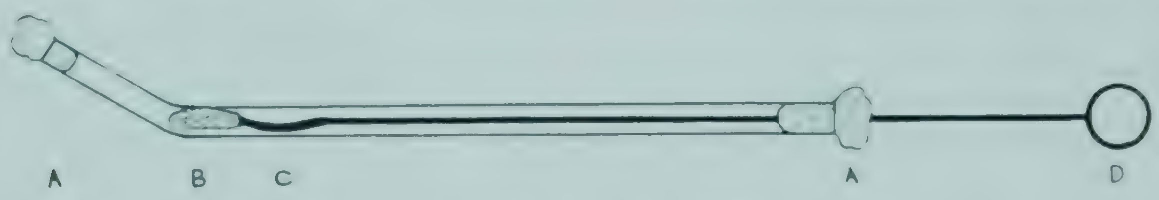

Fig. 105.—West's Post-Nasal Tube.

A Cotton Wool Plugs.
B Cotton Wool Swab.
C Glass Canula.
D Handle.

Sulphapyridine, sulphanilamide, sulphathiazole and sulphadiazine are now approved remedies for cerebrospinal fever. Sulphadiazine appears to be the least toxic and is probably the most effective of the sulphonamide series in the treatment of meningitis. The selected drug should be pushed to the limit of tolerance and, where necessary, beyond it. In severe cases the first dose should be given by the intravenous route, and the fluid intake of patients should be kept high. Penicillin is also effective. It should be given both by the intrathecal and intramuscular routes. Treatment should be controlled by successive lumbar punctures. Serum treatment of the disease is now obsolescent but may be required in cases where the chemotherapeutic agents prove too toxic or are inert. In such instances the antiserum, either polyvalent or type-specific, is diluted to thrice its volume with 10 per cent. glucose saline, heated to body temperature and injected slowly by the intravenous route. Intrathecal injection is nowadays less favoured. When it is used the dose of antiserum should be 20 to 30 ml. for a child and 30 to 60 ml. for an adult. Rather more than this amount of cerebrospinal fluid should be withdrawn on each occasion before the antiserum is introduced. Injections should be repeated daily until the meningococcus disappears from the fluid. Daily drainage of the theca by lumbar puncture is an additional therapeutic measure of value.

The infection, which is spray borne, is mainly derived from carriers, who may be numerous during epidemic periods. To demonstrate the carrier condition a West's post-nasal tube (Fig. 105) is passed into the nasopharynx of the person and any organism so recovered inoculated at once upon the special culture medium, which must then be kept warm during transit to the laboratory. Otherwise the fragile meningococci, if present, may die en route. The Ministry of Health in a recent memorandum discourages as unprofitable the systematic search for meningococcal carriers.

There is no specific prophylactic available for the control of cerebrospinal fever. Efforts should be directed towards attenuating the spray-borne infection by the avoidance of overcrowding in living quarters, in workshops and in transport vehicles or ships. The windows of class rooms and barrack rooms should be kept wide open. Beds in dormitories should be at least 2 feet apart. In suitable weather it is better still to sleep out of doors. Chill and bodily fatigue, which predispose to the infection, should as far as possible be minimised. Under such conditions the carrier state usually proves of short duration and cases cease to occur. A few refractory carriers may enter upon a chronic stage during which it is desirable to keep them under notice. Vaccines are ineffective against the carrier condition, as also are insufflations of solutions of chloramin T. Good results have followed the administration of sulphadiazine in doses of 3 to 4 grams over a period of four days.

Cases of infective meningitis due to *Pneumococcus, Staphylococcus* or *H. influenzae,* should be treated by the intra-thecal injection of penicillin.

Chicken Pox

Chicken Pox or Varicella, which is due to a filter passer, seemingly strongly akin to that of zoster, is in general a mild affection but may on occasion be complicated by sepsis and leave deep scars. The maximum incidence is about the sixth year of life but an attack may occur at any age. One attack generally confers a lasting immunity. Transmission is generally by the aerial route, but fomites may play a part. The differential diagnosis of chicken pox and smallpox is often important.

The eruption of chicken pox is most abundant on the trunk (Fig. 106) usually showing first on the chest without prodromal rashes or systemic disturbance, and first noticed in the vesicular stage. In children it appears on the first day of illness, but in adults may be preceded by a day or two of constitutional disturbance. The ordered sequence of smallpox is absent: the lesions continue to come out in crops so that crusts and vesicles may lie side by side in the same area of skin. The vesicle of chicken pox is thin-walled and unilocular: it readily collapses when pricked, and passes rapidly to the crusting stage, pustulation being suppressed. Haemorrhagic and gangrenous types of the disease are occasionally encountered.

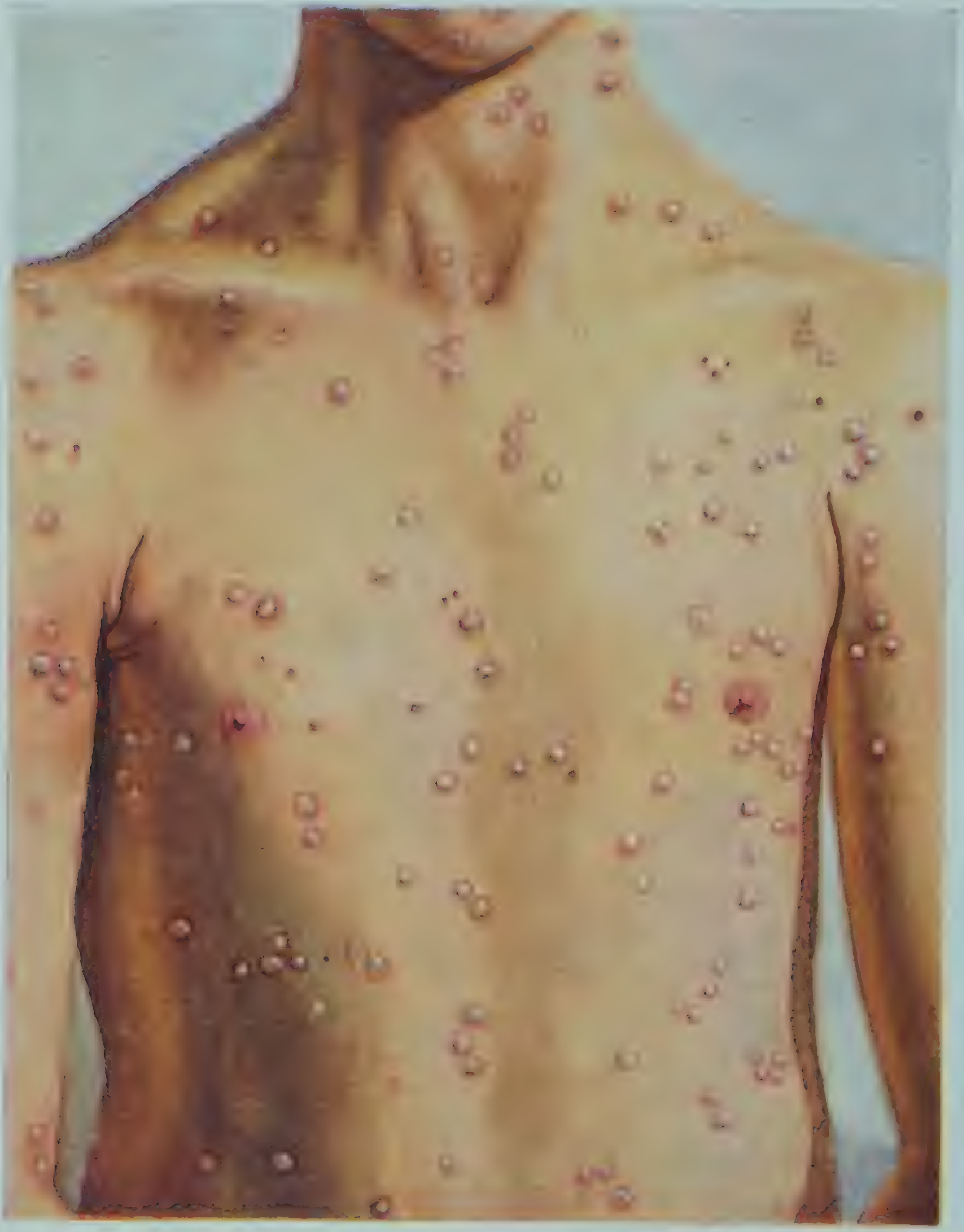

Fig. 106.—Chicken Pox.

The case shows a heavy infection such as may be confused with smallpox. The concentration of the eruption on the trunk is characteristic. Earlier in the infection all stages of the lesion, *i.e.*, macules, papules, vesicles, and pustules, would have been seen co-existing. The rash is on the wane, macules and papules are therefore scanty.

In a child under 10, well-vaccinated in infancy, an eruption exhibiting vesicles and crusts is much more likely to be chicken pox than smallpox. In time of smallpox it has been found useful to make chicken pox compulsorily notifiable.

Chicken pox may require to be distinguished also from zoster, pemphigus and scabies. Pain and often severe constitutional disturbance are associated with zoster and pemphigus. The demonstration of sarcoptes in the lesions confirms the diagnosis in scabies. Treatment begins with a calomel purge. A calamine lotion applied to the skin will allay irritation and prevent scarring, as also will Mitman's paint, consisting of 15 per cent. tannic acid in collodion.

Cholera

This disease has long been endemic on the lower Ganges and Bramaputra and is still widely prevalent in Asia and the Far East. Of its five pandemics during the nineteenth century three involved Britain.

The attack of cholera begins with evacuation of the bowel attended by languor and depression. Then griping diarrhoea sets in, with rice-water stools later. Next ensues the algid stage, which is marked by a subnormal temperature with clammy skin and failing circulation. The breath is cold and the voice reduced to a whisper. In cases which recover, the symptoms recede in the reverse order of their onset. In *cholera sicca* death may anticipate the characteristic purging. Hyperpyrexial cases with temperature up to 107° F. are with few exceptions fatal. The average case mortality is 50 per cent. The most effective treatment is that of Sir L. Rogers by the use of potassium permanganate pills and intravenous or subcutaneous hypertonic saline. Kaolin administered freely by the mouth may absorb cholera toxins from the bowel. The bacteriophage has proved capricious in its therapeutic action.

The infective agent in cholera is *Vibrio cholerae,* which invades by way of the mouth and is readily demonstrable in the dejecta of patients on direct microscopic examination. The infection is most commonly water-borne, especially from wells, but may be conveyed also by food such as fruit and vegetables. It may be carried to milk by flies. In addition to cases, convalescent and contact carriers may be infective sources, as may be also ambulant cases of Cholerine, a mild variant of the disease. The period between infection and onset ranges from a few hours up to 10 days. The carrier state is usually of brief duration, up to a few weeks.

Measures for the prevention of cholera are the isolation of the sick, together with the disinfection of their excreta, and scrupulous cleanliness on the part of their attendants, the safe disposal of the bodies of the dead, the control of contacts and carriers, the repression of flies and the protection of food and water. Water under suspicion should be boiled or chlorinated, and wells and springs treated with potassium permanganate or the specific bacteriophage. The personal prophylactic is Haffkine's anti-cholera vaccine, given in two injections with 10 days between, the first containing 4,000 million vibrios and the second double that number. The protective value of Haffkine's vaccine has been amply demonstrated. Besredka's oral bili-vaccines are rather less effective.

Dengue

This fever has a sudden onset with malaise, intense frontal headache and severe pains in the bones and joints. There are two rashes, the initial scarlatiniform and the terminal rubeolar. Temperature falls about the seventh day and a slow convalescence begins attended by neurasthenic symptoms. Dengue is mainly tropical and subtropical, and occurs in the West Indies, Brazil and Asia Minor, breaking out at times with extreme violence and temporarily prostrating entire populations. Widespread epidemics occurred in Greece in 1927 and 1928. Uncomplicated dengue is seldom fatal. The virus of the disease is ultra-microscopic and is present in the blood during the first three days of illness. The vector is *Aëdes aegypti*, which becomes infective in 11 to 14 days after biting a patient, and remains a life-long carrier of the virus. The vector in the Orient is *A. albopictus*.

Dental Fluorosis

This dystrophy of the teeth of children begins with a dark mottling of the enamel, which may go on to permanent blackening or even disintegration of the dental substance. The lesion has principally been observed among communities using water derived from deep wells in bauxite, natural phosphate or similar strata. The active agent of the mischief is fluorine, which occurs in these formations. One part per million of the element enables a water to start the process of destruction, which, it should be noted, is almost exclusively limited to the permanent teeth.

Since fluorine, though most abundant in volcanic areas, is widely though sparingly dispersed elsewhere, fluorosis has been recorded in various parts of the world. It was first recognised in the United States among immigrants from Pozzuoli on the slopes of Vesuvius. It is known in West Texas and North Africa, in India and the Far East, and in some European countries, including England where cases have occurred in Essex.

With a view to the prevention of dental fluorosis fluorine-charged waters have been dosed with tri-calcium phosphate. A change of water supply under expert guidance is, wherever possible, a better plan.

Diphtheria

Diphtheria appears to have been observed by Hippocrates who says that in tonsular ulceration a webby exudate is ‘no good thing.’ He refers further to the occurrence in such cases of dyspnoea and late paralysis. Aëtius in the sixth century A.D. also describes the ulcers on the tonsils, and states that as patients begin to recover they speak thickly and return fluids by the nose. An outbreak of diphtheria with high mortality took place in Rome in the year 1004. As already noted, Spain was afflicted in early modern times, the visitation culminating in 1613. Twice during the nineteenth century the disease attained special severity in Britain.

The specific agent of the infection is B. diphtheriae (*Corynebacterium diphtheriae*) of which three strains are recognised. One, B. diphtheriae *gravis*, produces a severe type of attack, another, B. diphtheriae *mitis*, causes a milder illness. Between the two comes B. diphtheriae *intermedius*. The three strains are distinguishable by their cultural reactions on tellurite media. The infection is most prevalent during the fourth quarter of the year, and is spread mainly by the buccal spray of cases or carriers. It may be communicated also by fomites such as penholders and on occasion by milk. The bacillus can survive for a month or more outwith the human body. Congenital immunity to diphtheria declines to its lowest level towards the end of the first year of life and remains low thereafter until the age of three or four. Almost 60 per cent. of cases in urban areas are children under the age of ten. Material for bacteriological diagnosis is removed from the throat or elsewhere by means of a cotton-wool pledget mounted on a stiff wire. No antiseptic should have been applied to the throat for 12 hours previously. The Lederle swab, impregnated with horse serum, enables the bacillus to multiply on its way to the laboratory and so saves time. Grown on Löffler's serum, and stained by Neisser's method, B. diphtheriae presents the appearances shown. In many public health laboratories the standard Löffler serum technique has been replaced by the slower but more accurate tellurite procedure, which involves a delay in reporting of 2 to 3 days. The treatment of a suspect case should not be delayed while the laboratory findings are awaited. The bacteriological report may confirm, but cannot replace, the clinical diagnosis.

Symptoms. In an attack the organism proliferates locally, and the symptoms produced vary as under according to the situation of the affected surface.

Faucial. Visible membrane, uni- or bilateral. Foetor of breath. Rhinorrhoea. Enlarged submaxillary glands. Patient pale and quiet.

Laryngeal. Brassy cough. Then spasmodic dyspnoea. Finally permanent dyspnoea with alar breathing and recession of the intercostal spaces. Tracheotomy may be required.

Naso-Faucial. The most severe form, owing to the large surface available for absorption of the toxin.

Nasal. Discharge from the nostrils, which may be sanious. A danger to the community because cases are often missed.

Other Forms. On vulva or wounds. The membrane is atypical, but the characteristic complications may follow.

The affinity which diphtheria toxin possesses alike for heart muscle and peripheral nerves is reflected in the cardiac and paretic complications which tend to appear about the fourteenth day of the illness. Of paretic involvements, that of the palate is the most common, but any muscle, including the diaphragm, may be affected by diphtheria.

Treatment. Rigid recumbency during the first two weeks is prophylactic of complications. Specific therapy by the intramuscular injection of diphtheria antitoxin should be begun whenever suspicion of diphtheria arises. The concentrated globulin preparation is to be preferred as it involves the least risk of serum disease. For mild cases 2000 to 8000 units are usually sufficient and should be given intramuscularly. In *gravis* infections, doses up to 100,000 units by the intravenous route may be required. In cases of supersensitivity the dose should be fractionated. If the throat is septic, intramuscular injections should not be deep, lest an abscess form at the site. Sulphonamides are of value in septic cases and should be used in conjunction with serum. Local treatment is of little avail for the diphtheritic condition. Remedies may be required for the failing heart and should be sedative rather than stimulant. The use of the steam tent is advised in laryngeal cases. Failure of the diaphragm may necessitate the employment of the mechanical respirator.

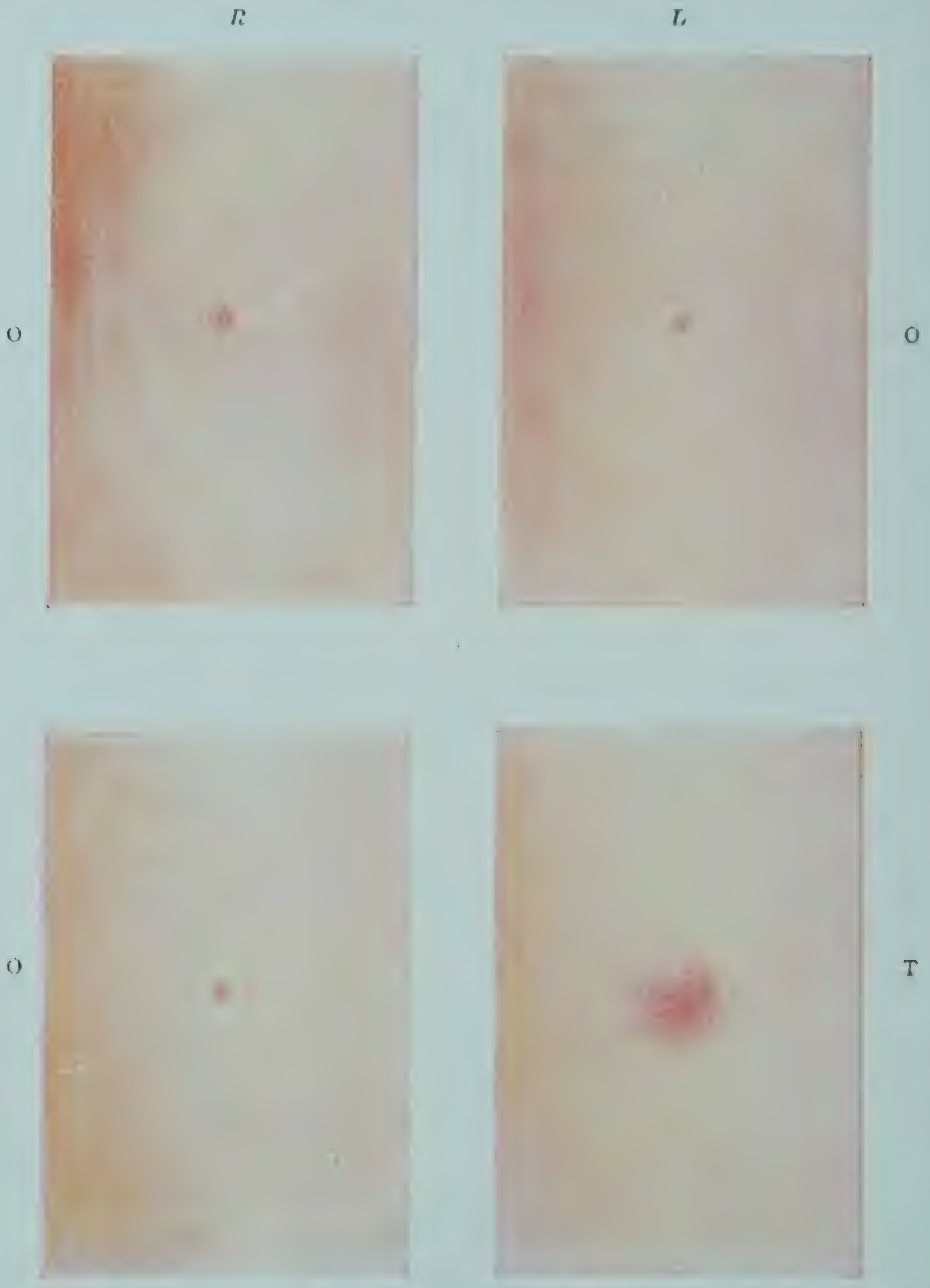

Fig. 107.—Schick Test.
Key to lettering on page 448.

Schick Test. This test is employed in order to determine susceptibility to diphtheria. 0·2 ml. of a toxin dilution 1 ml. of which equals 0·1 M.L.D. is introduced into the flexor aspect of the left forearm, and as a control the same amount of the toxin dilution inactivated by heating at 75° C. for 10 minutes is similarly injected into the skin of the right forearm. The toxin reaction (Fig. 107) is shown by an area of redness which reaches its height on the fourth day and on fading leaves pigmentation and scaling. A protein reaction (Fig. 108) due to supersensitiveness of the person to protein in the material injected may also appear in some cases. The protein reaction reaches its height in about 24 hours, shows less pigmentation on fading than the toxin reaction, and does not scale. Taking L = left arm, R = right arm, O = no reaction, T = toxin reaction, P = protein reaction, I = insusceptible and S =

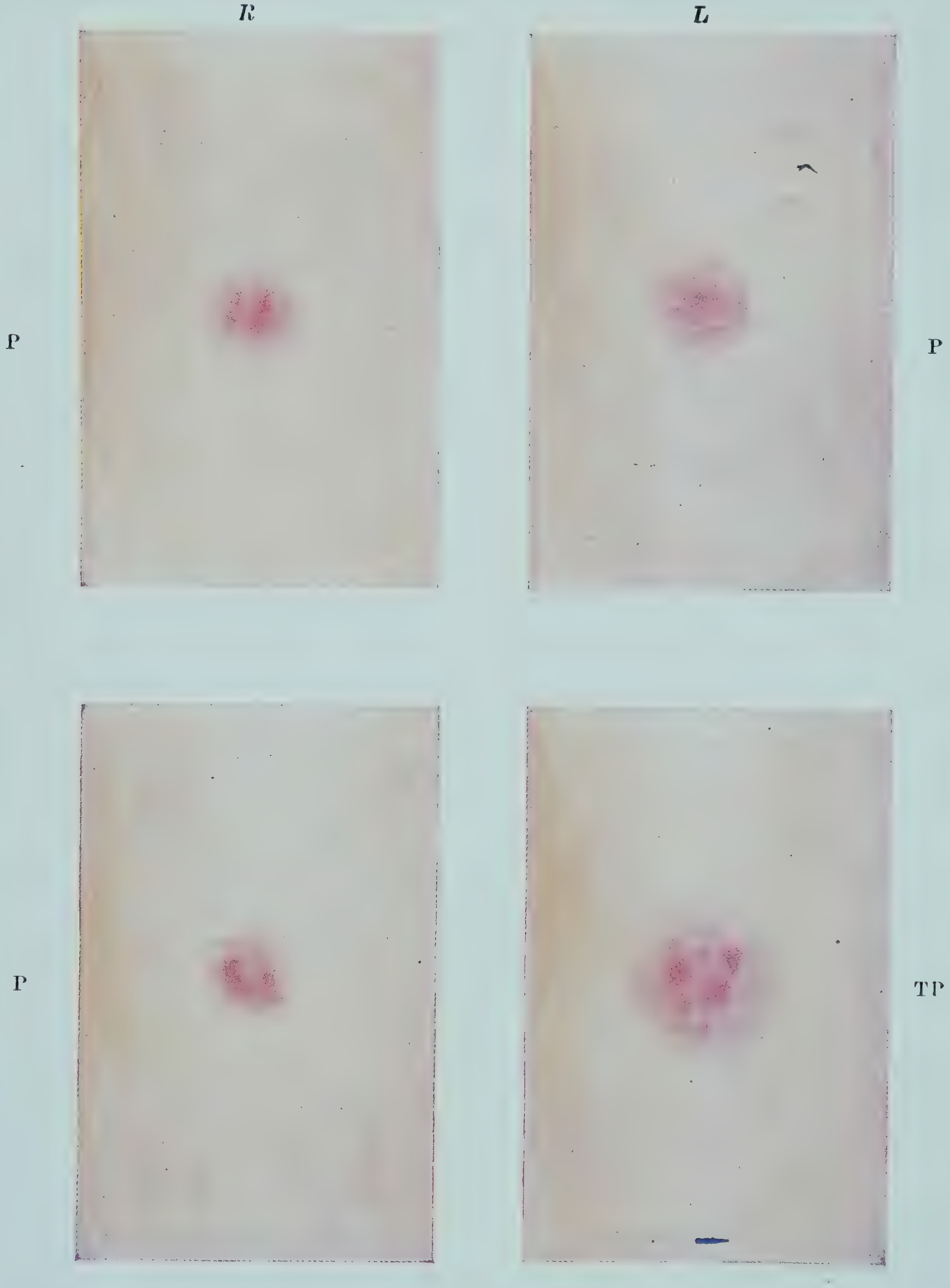

Fig. 108.—Schick Test.
Key to lettering on page 448.

susceptible, the subjoined form summarises the appearances presented and shows the conclusions to be drawn :

L	O	T	P	TP
R	O	O	P	P
	I	S	I	S

The test may be employed to assist the diagnosis of doubtful cases of diphtheria by demonstrating the presence or absence of immunity.

Moloney Test. The purpose of this test is to determine supersensitivity to formol toxoid and alum precipitated toxoid in a person proposed to be actively immunised to diphtheria by the injection of these substances. Before the immunising injection is given a minute quantity, say 0·2 ml., of the formol toxoid is injected intradermally. If a wheal accompanied by induration arises on the skin within 24 hours the person is supersensitive and the use of formol toxoid is in general contraindicated. If no wheal arises the immunisation with formol toxoid may proceed.

Active Immunisation against diphtheria may be carried out on a community basis, or on special groups such as fever nurses or pupils in a boarding school, or on individuals who may desire such protection. It is customarily offered by the child welfare clinics and by the school medical service. Campaigns with the aid of mobile immunisation units have met with considerable success in populous areas. Prior to the outbreak of the Second World War immunisation of children against diphtheria had been made compulsory in certain European countries, including France and Italy. The continuous practice of immunisation in the United States has led to a spectacular decline in deaths from diphtheria. Immunity develops rather slowly, 6 weeks or longer being necessary. Once established it usually persists for long periods. The immunity conferred is antitoxic but not bactericidal. This means that school children may become healthy carriers and it thus emphasises the need for routine immunisation at pre-school ages. The preparations employed are 4 in number, namely, Formol Toxoid, Toxoid-Antitoxin Floccules, Alum Precipitated Toxoid, and Toxoid-Antitoxin Mixture.

1. *Formol Toxoid*, lettered F.T., is known also as Anatoxin. Three doses, varying from 0·2 to 0·6 ml., are given with three weeks between. Persons who are Moloney positive should in general not be immunised with formol toxoid, though the difficulty may in some cases be overcome by fractionating the dose.

2. *Toxoid-Antitoxin Floccules* (Schmidt), lettered T.A.F., are prepared by flocculation *in vitro*. The floccules cause no reaction and are suitable for children as well as for Moloney-positive adults. Three doses of 1 ml. are given with 2 weeks between successive doses.

3. *Alum-Precipitated Toxoid*, lettered A.P.T., has been claimed to cause no ill-effects even when the whole immunising charge is given in a single dose. It is however safer in the meantime to administer it in two

doses, the first of 0·2 ml. and the second, a month later, of 0·5 ml. A.P.T. is the preparation most employed in community immunisation.

4. *Toxoid-Antitoxin Mixture,* lettered T.A.M., consists of toxin partially neutralised by antitoxin. Three doses of 1 ml. are given with four weeks between. There is little or no reaction.

Success or failure of the immunising process may be determined by the application of the Schick test, not less than twelve weeks after the last immunising dose has been given. Children who have been immunised in infancy should receive a single 'booster' injection of 0·5 ml. before beginning school. B. R. Nisbet, applying serial Schick tests to immunised children at Kilmarnock over a period of years, has shown that 6 per cent. had lost their immunity by the second year after injection while, by the seventh year, the figure had risen to 20 per cent.

Diphtheria in partially immune child subjects may present appearances which are clinically atypical and so is apt to be missed. Such children are usually those who have not had the full course of injections in infancy, or have missed the additional injection at school age.

Passive Immunisation. Diphtheria antitoxin should be administered to home contacts with diphtheria with the object of maintaining passive immunity in them over the incubation period of the disease. In scarlet fever or other hospital wards cross-infected with diphtheria the same precaution should be taken. A dose of 2000 units suffices for prophylaxis.

Carriers. The diphtheria bacilli recovered from the throat or nose of a carrier may or may not be virulent, that is to say, capable of producing disease. The evidence of virulence is a rose-red swelling, with necrosis, of the abdominal skin of a test guinea pig produced by the intradermal injection of an emulsion of the particular strain. Carriers of non-virulent bacilli are harmless to the community: they require neither segregation nor treatment. Carriers of virulent strains should be kept under supervision. Persistent carriers may present abnormalities of the throat, nose or nasopharynx. Tonsillectomy or removal of adenoids may cure their carrier state. They should have as much fresh air and sunlight as possible. Applications of dimol, argyrol and other chemical substances have from time to time been tried, but have been found capricious in action. Tellurite media are of particular service in the detection of convalescent and contact carriers. It appears that the co-existence of haemolytic streptococci in the throat predisposes to the carrier state. Such incidental streptococcal infections may be overcome by the inhalation of sulphanilamide snuff.

Dysentery, Amoebic

Amoebic dysentery, or intestinal amoebiasis, to which is related amoebic abscess of the liver, is tropical and subtropical, and occurs in India, the Far East, and South America. On the Gold Coast, and in Kenya, it may be more common than the bacillary form of the disease.

Following an incubation period which varies from 1 to 12 weeks, the syndrome is one of chronic apyrexial diarrhoea characterised by dark-coloured offensive stools containing altered blood but few leucocytes.

The lesions are ulcers of the large intestine, oval in shape and regular in outline, with the intervening surface unaffected. The specific agent is *Entamoeba histolytica* (Fig. 109) which inhabits the intestinal wall especially the mucous and submucous layers. During the acute attack it is expelled in large numbers with the excreta. Between attacks it forms quadrinucleate cysts which are expelled likewise. These cysts, if swallowed by another human host, liberate entamoebae and reproduce the lesion. The active amoeba, when cast out, dies without encysting. As infection is transmitted exclusively by the cysts, and as the cysts are formed only during quiescent periods, amoebic dysentery is not known in the epidemic form. Many persons in apparent health have amoebic ulceration, harbouring entamoebae and excreting cysts without the pains of dysentery. It has been estimated that some 3 per cent. of persons in the United Kingdom are cyst passers, a figure likely to be increased by the return to this country of troops from service in endemic areas. Cats are susceptible to the disease and may disseminate cysts.

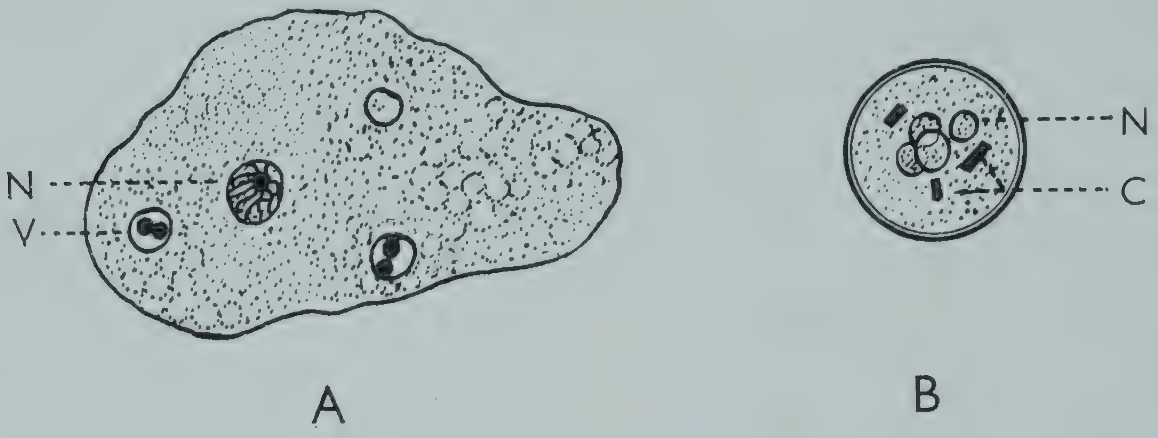

Fig. 109.—Entamoeba histolytica and cyst.

A. Warm stage specimen. Red cells in situ.
B. Typical quadrinucleate cyst.

Diagnosis is established by finding vegetative entamoebae or their cysts in fresh faecal films. The warm stage should be employed, and some practice is required in order to distinguish the cysts both from those of commensal amoebae and from organisms such as *Blastocystis*. Irrigation of preparations with iodine is helpful in demonstrating the presence of cysts.

The approved medicaments for amoebiasis are emetine hydrochloride, emetine-bismuth-iodide, lettered E.B.I.: emetine periodide, lettered E.P.I., and iodo-oxyquinolin-sulphonic acid, known as Yatren or Quinoxyl. Emetine destroys entamoebae located in tissue. The adult dose of the hydrochloride is one grain daily given intramuscularly for a period of 10 days. The drug is toxic and cumulative and should be used with caution, especially in children, who should receive rather less than the standard age-dose. The patient should be confined to bed during the treatment. A second course of emetine may, if required, be given after an interval of two weeks. To kill the parasites and their cysts in the bowel lumen, a follow-up course of E.B.I., consisting of seven nightly doses each of 3 grains, is recommended. When E.P.I. is used, it should be given thrice daily in 2-grain doses for 12 to 15 days. Good results are claimed for the combined treatment, which supplements the standard emetine-E.B.I. course by rectal irrigation with Yatren in 2 per cent. solution.

Exceptionally the amoebae migrate from the ulcerated bowel, the primary lesion, to the liver, spleen, brain or skin, where they set up abscess, the secondary lesion. Parasites in secondary lesions may reproduce for several generations by fission. Encystment, however, never occurs, transmission to a new host is impossible, and so their race perishes.

Amoebic liver abscess is characterised by hepatic enlargement, dyspepsia, irregular fever and cachexia. The lesion may kill by exhaustion or by rupture into the pleural or peritoneal cavity. The treatment is by emetine injection followed by aspiration of the chocolate-coloured pus. The patient should then receive the standard emetine course or its equivalent. Pulmonary, splenic and dermal amoebiases also are amenable to the specific action of emetine.

Amoebic dysentery is transmitted by water, fresh vegetables and house flies. The prophylactic measures are cleanliness, good sanitation and fly repression. Drinking water should be stored or filtered or, best, boiled. Known cyst-passers should not be allowed to handle food.

Dysentery, Bacillary

Bacillary dysentery, as contrasted with amoebic, may attain epidemic prevalence. The typical onset is acute, with griping intestinal pain and tenesmus accompanied by prostration. Fever is usual and there may be hyperpyrexia. The blood-stained, viscid and odourless stools are thronged with dysentery bacilli and rich in leucocytes. The pathological state is a diffuse necrosis of the mucosa of the large intestine. Any ulcers present are serpiginous, with ragged and undermined edges. Occasionally 'retention cysts' form in the mucosa. These retain the bacilli for long periods, so giving rise to the carrier condition. Arthritis and irido-cyclitis are complications. Attacks may be mild, severe or relapsing, or the disease may assume a chronic character. Case mortality varies from 6 to 30 per cent. In children the illness may take the form of enterocolitis with green stools.

Among the bacilli responsible are *B. dysenteriae* (Shiga), *B. dysenteriae* (Flexner) and *B. dysenteriae* (Sonne). The glucose-fermenting Newcastle strain has lately been responsible for many cases. Atypical dysentery bacteria such as *B. dispar,* the Schmitz bacillus and Morgan's bacillus may also cause attacks. Epidemics occur in both the tropics and temperate countries. In Europe the disease is mainly one of institutions such as barracks and mental hospitals. The Sonne type of illness tends to be mild.

Diagnosis is confirmed by bacteriological examination of the stools, preferably during the first three days of the illness. Transit of specimens to the laboratory should be rapid. Where delay is inevitable, the addition of 30 per cent. neutral glycerine in saline to the stool may assist in keeping the bacilli alive. Specimens obtained by means of rectal swabs are more likely to yield positive results. Agglutinins appear in the patient's blood after the seventh day. Diagnostic titres are 1 in 40, 1 in 150 and 1 in 100 for the Shiga, Flexner and Sonne strains respectively.

Mild cases and carriers are active disseminators of the disease. The carrier condition follows in 3 per cent. of recoveries and may persist up to 9 months. To prevent outbreaks water supplies should be chlorinated and food sources such as milk, and especially ice-cream, pasteurised. Fly prevalence should be reduced and all sanitary requirements enforced. Obscure cases of illness should be observed in isolation. Steps should be taken to identify carriers, who should be treated with sulphadiazine or, in the case of Sonne carriers, with sulphanilylbenzamide. No carriers should be permitted to handle food.

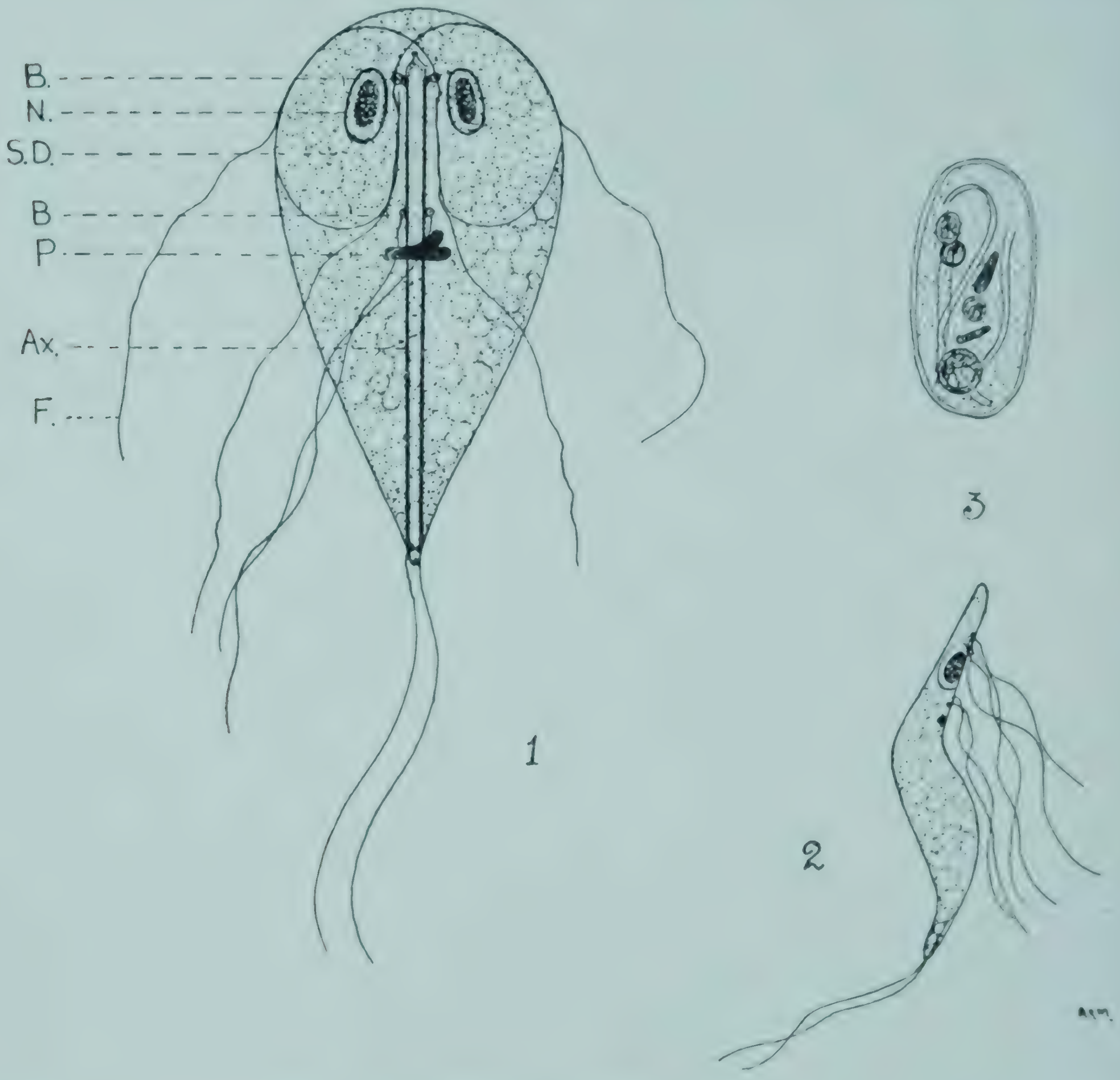

Fig. 110.—Giardia lamblia. (×1500.)

1. Vegetative form. *Ax.*, axostyles: *B.*, blepharoplast: *F.*, flagellum: *N.*, nucleus: *P.*, parabasal; *S.D.*, sucking disc. 2. Vegetative Form, Side View. 3. Cyst.

The treatment of severe cases of bacillary dysentery should begin with a brisk purge followed immediately by the intravenous injection of 60 to 100 ml. of polyvalent antiserum. Excellent results now follow the oral administration of sulphaguanidine. In Sonne infections even better results are obtained with succinylsulphathiazole. The adult dose is 3 grams 4 times daily for 3 days, followed by 3 grams twice daily for 4 days. Children should receive half these amounts. A full fluid intake must be maintained during both sulphadiazine and sulphaguanidine therapy. Yatren is of value in chronic cases. Prophylactic inoculation has not been widely employed on account of the toxic effects of the vaccines, but Shiga by sensitising the dead cultures has been able to control the severity of the reaction.

Dysenteries, Other

Blood-fluke dysentery, or intestinal schistosomiasis, due to the presence in the lower bowel of *Schistosoma mansoni,*[1] is attended by dysenteric symptoms, often severe, and by rectal polyposis and splenomegaly. Treatment is by the intravenous injection of tartar emetic, or by emetine hydrochloride. Drinking water should be boiled and bathing in rivers in endemic areas is best avoided.

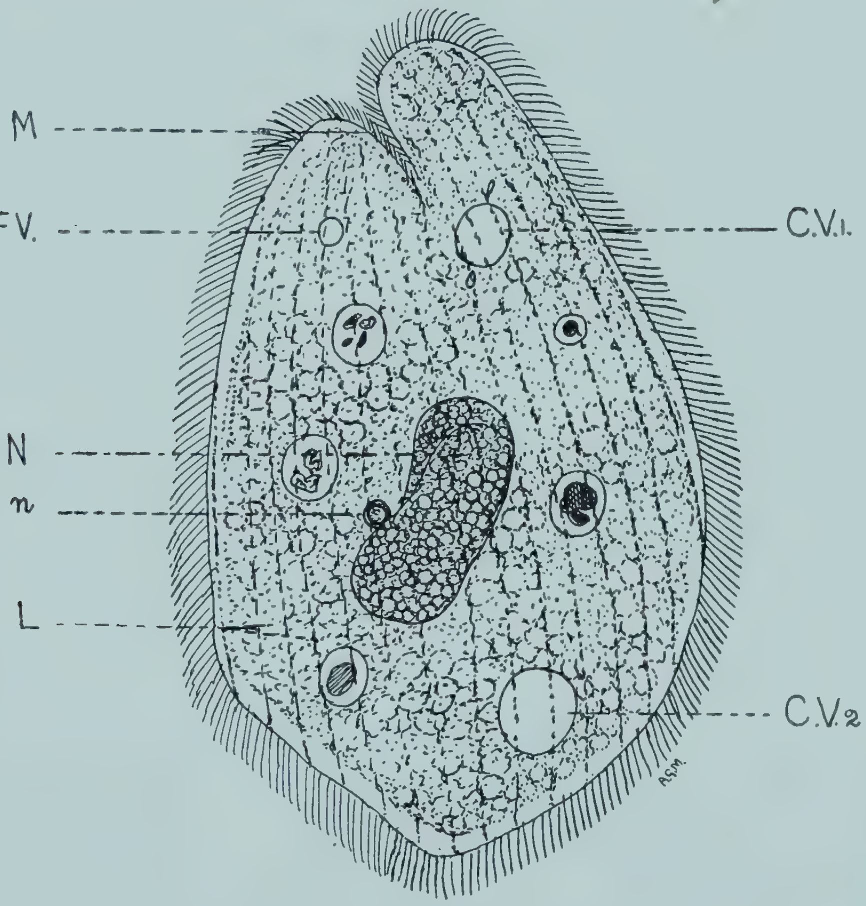

Fig. 111.—Balantidium coli. (×900.)

C.V.1, C.V.2, contractile vacuoles: *F.V.*, food vacuole: *L.*, lines of insertion of cilia: *M.*, mouth: *N.*, macronucleus: *n.*, micronucleus.

Giardiasis, known also as Lambliiasis, is of cosmopolitan distribution, and has lately shown some prevalence in Britain. It is caused by the intestinal flagellate *Giardia intestinalis.* Chronic dysentery, flatulence, anorexia and lassitude are the symptoms. Children are more often affected than adults. Mepacrine has been employed with success in treatment. Diagnosis is established by finding the parasite, or its characteristic ova cysts, in the stool (Fig. 110).

Balantidium coli (Fig. 111), a ciliate, is normally a commensal in the caecum of the pig, but may on occasion be transferred to Man. When it is present in the human intestine in large numbers a dysenteric syndrome may be the result.

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[1] Page 526.

It should be noted that symptoms resembling those of the true dysenteries occur in malaria and kala azar.

Encephalitis Lethargica

The first definite recognition of encephalitis lethargica is dated 1917. In April of that year R. Cruchet of Bordeaux described a new disease, observed by him in French soldiers, which presented the characters of a subacute encephalo-myelitis. A few days later there was published in Vienna an independent account by C. von Economo, who introduced the name Encephalitis Lethargica. In 1918 the new disease appeared in England and in 1919 was made generally notifiable.

Four varieties of the disease are now recognised in the United States. These are the Vienna or A type, the St. Louis type and the Western and Eastern Equine types. The Vienna form corresponds to the von Economo type of Britain. The St. Louis type has a more acute onset, often with disorientation, but is otherwise similar, as is the Western Equine type. The Eastern Equine type is a severe infection with a tendency to post-encephalitic sequelae. It is not infrequently fatal. It is suggested that separate viruses are responsible for the four types of the illness.

The attack of encephalitis lethargica is commonly ushered in by a prodromal period of somnolence, headache, diplopia and general weakness. There may be soreness or dryness of the throat or vomiting and diarrhoea. In the acute stage, which is attended by fever of 101° to 102° F., there is headache with stupor and general disturbance of the central nervous system, or else the infection may be localised in the oculomotor and other nerves, as evidenced by diplopia, squint, nystagmus, ptosis, neuralgia, facial spasm, hiccough, dysphagia and choreiform movements. In some cases the hiccough accompanied by rise of temperature may be the sole obvious clinical indication. Emaciation and incontinence may set in and lead to bed sores. In the severest cases there may be complete immobility, catalepsy or coma. Mortality ranges from 20 to 50 per cent. The subsequent phases in those who survive, although often termed sequelae, represent a continuing infective process, as shown by the presence in late fatal cases of subacute inflammation of the mesencephalon. The late phases may include the Parkinsonian syndrome, myoclonus, spinal paralysis, athetosis and a general degradation of character and conduct resulting in delinquency.

Encephalitis lethargica is a malady of low infective power from case to case. Doctors and nurses are seldom attacked and, though grouping is not unknown, cases usually occur singly without obvious association with one another. The disease is believed to be kept alive by carriers, aided by mild or missed cases. The infective agent, a filter passer, is spray borne, its source being the nasopharynx. It has recently been suggested that certain of the American Equine types may be mosquito-borne, since these insects are capable of transmitting the virus under laboratory conditions. No period of life is exempt from attack but the age of election is from 10 to 20 years.

Encephalitis patients should be hospitalised and contacts of school age excluded from school. No specific remedy is yet available and treatment is mainly symptomatic. Nasal or rectal feeding may be required. At a time of prevalence people should seek medical advice for even minor febrile attacks or slight sore throat. Cases of post-encephalitic disablement and delinquency should receive special re-educative treatment in residential institutions in the hope of their ultimate rehabilitation. In this connection a more careful scrutiny of the previous medical histories of offenders at juvenile courts is required. Certain of such cases now come within the ambit of the Mental Deficiency Acts.[1]

Endemic Goitre

Of all the tissues of man the thyroid gland is the richest in iodine, its function being to furnish iodine for the routine uses of the body, and also to issue emergency supplies for special needs as at menstruation or during the course of specific infections. In order that it may be in a position to distribute the amount required the gland must receive an equivalent quantity in the food consumed by the person. If however in any district the native iodine is low and food stuffs in consequence weak in the element, the iodine intake of the people will fall below their need. In such cases the thyroid undergoes a compensatory hypertrophy known as ‘endemic goitre,’ in which the enlarged gland shows a normal structure combined with a marked reduction of its iodine percentage. Sometimes an emergency call for iodine may lead rapidly to thyroid enlargement, as when race-horses in New Zealand become goitrous under the stress of training.

Plants take up and hold iodine which when they die becomes fixed in humus and, so protected, is able to resist the scouring action of rain. Such soils are iodine-rich. Soils however in which lime is abundant are friable and tend to break up. The humus in them is torn in pieces and its iodine washed away. Such soils are iodine-deficient, and favourable to the prevalence of goitre. A marked example is the Laurentian limestone in North America. Goitre is infrequent near the sea owing to the consumption of marine fish which contain the necessary element, but it is endemic among the inhabitants of mountainous regions such as the Himalayas, the Rocky Mountains, the Andes and the Alps. It occurs also on the Cotswold Hills and on the Mendips, and in Derbyshire, Cornwall and other English counties as well as in parts of Scotland.

Simple goitre is the prevalent type in endemic areas. Its incidence appears to correspond broadly with that of dental fluorosis. It may be accompanied by some incidence of cretinism, thyroid adenoma and exophthalmic goitre. The female cases outnumber the males. Where goitre is notably endemic in man the domesticated animals are involved also, with serious losses to stock. Low iodine content of food stuffs has been demonstrated in goitrous areas. Examinations of water supplies for iodine have for the most part given conflicting results.

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[1] Page 74.

Treatment with iodine has been found effective for the control of endemic goitre, both to prevent the development of new cases and to reduce existing enlargements. For children the dosage is 30 grains as NaI spread over a fortnight twice in the year, not more than 5 grains being given on any one day. The organic preparation di-iodo-tyrosin has lately been employed successfully. Mass treatment has been achieved by taking over control of the salt supply and issuing 'iodised' table salt, containing NaI 1 part per 10,000, or, as at Rochester, N.Y., by dosing the town's water for a fortnight twice in the year with enough NaI to give a concentration of 0·08 part of iodine per million. Mass iodisation has been found in some cases to aggravate the hyperthyroidism of exophthalmic goitre, in others to excite proliferation of existing adenomata.

For the treatment of child cretins, thyroid extract is the appropriate remedy, beginning with ½ grain thrice per day and rising to 5 grains daily, subject to the development of tachycardia which signifies overdosage.

Epidemic Enteritis

This title is applied to the diarrhoea which is apt to prevail in hot, dry weather among infants in large towns and more particularly in crowded quarters. Bottle-fed infants, who suffer almost exclusively, are believed to become infected by way of the milk they are fed on, and there is evidence that the infection is conveyed to the milk by dust and flies. The disease is responsible for more than 3,000 deaths annually in England and Wales.

The diarrhoea of epidemic enteritis is severe, with green and in some cases rice-water stools and rapidly ensuing exhaustion and loss of weight. Cases may die in a few days. The younger the child, the more likely is the infection to prove fatal. The risk is maximal in premature infants. Among organisms which have been isolated from the dejecta are *B. Morgan* No. 1, *B. enteritidis* of Gärtner, *B. dysenteriae* (Flexner), *B. dysenteriae* (Sonne), *B. proteus* and *B. paracolon*. Specimens of stool for bacteriological examination should be obtained by means of rectal swabs.

The preventive measures include efficient scavenging and supervision of the yards about houses, high standards of personal and household cleanliness, particularly with regard to food preparing, anti-muscid measures, and the protection of food, together with breast feeding, failing which hand feeding with pasteurised milk. Particular care is required in the disposal of infected bed linen, especially in babies' wards. Treatment is mainly dietetic. Sulphaguanidine also has been found remedial. Intravenous glucose-saline may be necessary when dehydration is severe. The death rate from epidemic enteritis has been declining in recent years.

Epidemic Hepatitis

This disease, lately known as Epidemic Catarrhal Jaundice, has broken out from time to time in this country and elsewhere. There was a large epidemic round Peterborough in 1925 and another in Wensleydale in 1930. The disease appears to be spread by the buccal spray and children are mainly affected. The incubation period may extend to 40 days. Among the symptoms besides jaundice which have been noted are vomiting and epigastric pain with pains in the bones and back and tenderness over the gall bladder. Cases are in general mild. The possibility that the disease is a benign variant of infective jaundice has been entertained. It is however distinguished from Weil's disease by its longer incubation period, by its milder syndrome and by the accompanying monocytosis. Treatment is symptomatic.

Epidemic Hepatitis during the Second World War figured as a War disease in Continental Europe.

Ergotism

This is a disease condition resulting from the use of bread made from rye infested with the ergot *Claviceps purpurea*.[1] Two types are recognised. In the gangrenous type there is vasomotor constriction affecting especially the fingers and toes. In extreme cases the whole arm or leg may dry, shrink and finally separate. In the convulsive type the initial signs of weakness and lethargy are followed later by formication, cramps and paroxysmal convulsions.

Ergotism was a scourge to France during the Middle Ages and until quite recently was endemic in European countries where rye is a staple food. In 1927 there was an outbreak in Manchester affecting some 200 persons of the Jewish race. All the sick had consumed bread made from rye, in the remaining stocks of which ergot was demonstrated.

The measures to protect rye crops from Claviceps include deep ploughing, clearing fences of grass, and the correct rotation of crops. By the use of appropriate screens in milling the amount of ergot in infested rye can be substantially reduced. Mellanby regards vitamin A as protective against ergotism through its anti-neurotoxic factor.

Rye flour containing ergot when heated with potassium hydrate emits the herring brine odour of trimethylamine.

Erysipelas

This acute superficial inflammation is due to *Streptococcus haemolyticus* and is most common from October to January. It is mainly a disease of the poorer classes and shows a maximal incidence between the ages of 20 and 60. Erysipelas usually complicates a wound, burn, or vaccination but occasionally it is idiopathic. It is now realised that a high proportion of idiopathic facial cases derive from infection of the upper respiratory tract. Carriers of the infection are known to exist.

The incubation period is 3 to 8 days, after which a rigor ushers in the attack and the temperature quickly reaches 103° F. or higher. The characteristic lesion is a red shiny tender patch raised above the normal skin, pathognomonically pale in the centre and inflamed round the spreading edge. Suppuration may occur in severe cases. The chin and scalp are refractory to the disease. Termination of the illness is by crisis, commonly between the fifth and tenth days. Relapses are not unusual.

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[1] Page 265.

Under modern conditions erysipelas is treated by the administration of sulphonamide drugs such as sulphanilamide or sulphadiazine. In cases where erysipelas is complicated by a staphylococcal infection, sulphathiazole should be employed. Children tolerate these drugs well, which is important, since infantile erysipelas is often severe. As the result of extensive trials in Glasgow, T. Anderson recommends 6 to 9 grams of the chosen sulphonamide in the 24 hours, with one-third of these doses for children under five.

Foot and Mouth Disease

This highly infective epizootic, caused by a filter passing virus, is distinguished by vesicles on various parts of the animal body, especially the mouth and feet, together with constitutional signs. Cattle are principally affected, but sheep, pigs and goats may suffer also. The mortality among cattle is low, being less than ½ per cent., but there is a great falling off in the condition of the affected stock, and the only economic prophylactic appears to be immediate slaughter.

As the virus occurs in the milk of cows, and in the exudate from vesicles on their teats, the disease is readily conveyed to milk consumers. Affecting children it produces a vesicular eruption of the lips and buccal and pharyngeal mucosa, with fever, nausea, swelling of the tongue, salivation and cervical adenitis. Death is unusual, though it may supervene in the case of weakly children. In adults the disease is mild. Milk, butter and cheese should be pasteurised in areas of prevalence.

German Measles

As regards the manner of its disposition upon the skin of the patient, the exanthem of German measles, known also as rubella and due to a filter passer, is less diffuse than that of scarlet fever and not so blotchy as measles. Further, its colour is a light pink by contrast with the intenser red rash of scarlet fever and the carmine of measles. The coryza and Koplik's spots of true measles are absent. German measles is a mild infection occurring mainly in spring and summer. Young adults are most subject to attack, though children are not exempt. Enlargement of the glands along the posterior margin of the sternomastoids can as a rule be felt in cases occurring. Complications are rare, but non-fatal meningo-encephalitis has been recorded in recent years, occurring mainly in children. The blood serum of persons recovering from German measles has a prophylactic value.

Glanders

The disease known as Glanders or Farcy is set up in horses, asses and mules by infection with Bacillus mallei (*Pfeifferella mallei*). The discharges of the stricken animals may convey the infection to man.

In acute human glanders the infected focus breaks down rapidly to a discharging ulcer. A crop of pustules appears on the face, the lymph glands swell, subacute pneumonia sets in and death ensues in 8 to 10 days. In chronic human glanders there is persistent nasal discharge and generalised nodules are formed in the viscera or on the skin. Cases may survive for a month or longer and a few may even recover.

The bacteriological diagnosis of glanders in man may be made by isolating *B. mallei* from the discharges. Mallein, which is the filtrate from a heat-sterilised culture of the bacillus prepared for intradermal injection, should not be applied to the human subject. Treatment of the chronic dermal form of the disease is by excision of the cutaneous lesions.

Prophylactic measures include the quarantine of imported, and the slaughter of infected, animals, regular mallein-testing of blood stock, no common drinking troughs for horses, periodic disinfection of stables and farriers' premises and warning to grooms and ostlers.

Glandular Fever

This illness, which is also called infective mononucleosis, is characterised by rapid enlargement of the cervical and other glands, accompanied by fever and, in the case of children, by sore throat. The neck is stiff and tender. There is frequently conjunctivitis. Adult cases generally present a maculo-papular rash by the end of the first week. The leucocyte count may reach 20,000 mononuclears, constituting up to 90 per cent. of the cells. In the anginose form of the illness there is a faucial pseudo-membrane together with splenic enlargement. Complications are rare but recovery may be slow. The causal agent is unknown and the infectivity slight. It is believed that many cases escape notice. The malady is differentiated from lymphatic leukaemia and from Hodgkin's disease by the gland tenderness, by the mononucleosis, by the absence of anaemia and by the positive Paul Bunnell reaction which depends on the ability of the patient's serum to agglutinate sheeps' red cells to a high titre. Treatment is symptomatic.

Heat Stroke

This morbid condition, known also as 'heat exhaustion,' results from exposure to an environment which impedes the normal heat exchanges of the body and, if exposure continues, finally leads to derangement of the mechanism of heat control. In temperate climates it may be observed, usually in minor degrees, in overcrowded assemblies. In the tropics, given air humidity approaching saturation point and still weather, it occurs in the open, but if a breeze is blowing there is no heat stroke since the moving air evaporates moisture from the skin and keeps the body cool.

The attack may be precipitated by illness such as typhoid and dengue fevers or by wearing unsuitable clothing or by the immoderate use of alcoholic liquors. Following a prodromal stage of headache, anorexia and thirst, the onset is abrupt, with vertigo and vomiting, followed by coma and convulsions together with Cheyne-Stokes respiration. The skin is intensely hot to the touch. The rectal temperature may reach 112° F., and death supervene in a few hours. Less severe cases obtain relief from lying wrapped in a wet sheet in a stream of air propelled by a fan. Venesection is helpful in convulsive cases and artificial respiration may be required when the breathing weakens. After recovery from the seizure the temperature may remain high for several days. Convalescence may be attended by headache and mental confusion.

Heat stroke was formerly attributed to direct insolation of the head and was then called 'sun stroke.' This view is now known to be erroneous. Animals put out under a vertical sun with their heads exposed and their bodies kept cool have shown no ill effects. Further, Muslim pilgrims approach Mecca with their bare and new-shaven heads beaten upon all day long by the burning sun of Arabia, and take no hurt.

Hook Worm Disease

Bearing the alternative name of Ankylostomiasis, this disease is due to infestation by either *Ankylostoma duodenale*[1] or *Necator americanus*. It is prevalent in the Southern States of the American Union, in the West Indies, in Egypt, in Bengal and Madras and in the Assam tea gardens. It has occurred also in Cornwall.

The infestation begins when the encapsuled third stage larva penetrates the skin of the leg or foot, provoking the local dermatitis known in the tea gardens as 'ground itch' or 'coolie itch.' The Cornish tin miners were frequently invaded by way of their arms, on which the larvae raised painful 'bumps' or 'bunches.' Ova appear in the stools some 4 to 6 weeks after penetration of the skin by the larvae. A few hook worms may inhabit the intestine without causing apparent injury, but in early stages there is eosinophilia ranging from 10 to 20 per cent., and in established cases a progressive anaemia due to loss of the blood sucked out by the parasite, subsequent haemorrhage from the wound, and possibly a haemolytic action. The red cell count may fall to 2,000,000 and the colour index to 0·5. Digestive derangements, oedema and abdominal distension occur along with physical and mental inertia, accompanied by an earthy pallor of the skin. The course of the malady is chronic, with increasing anaemia, and the patient becomes a ready victim of intercurrent disease. Melancholia may result as a complication. In children mental and physical development are retarded, and in communities where infestation is rife, the total efficiency may be reduced to a low ebb. Diagnosis is made by the demonstration of hook worm eggs in the faeces of the patient. The specific remedies are tetrachlorethylene, hexylresorcinol and carbon tetrachloride. A convenient prescription consists of 4 ml. of tetrachlorethylene together with 1 ml. of oil of chenopodium given first thing in the morning. Carbon tetrachloride is not without danger. To control the disease, properly constructed latrines should be provided. They should be away from grass and their use made obligatory. Human excreta for use as manure may be disinfested by treatment with ammonium sulphate in 12 per cent. concentration for 24 hours. Brine spread over contaminated ground is larvicidal. Dipping bare feet in tar protects against larval invasion. The same end is served by issuing waterproof foot gear to coolies. In dealing with a community, the extent and intensity of infestation should first be determined by egg counts. Next there should be an educative propaganda by mobile laboratory and cinemotor van. Then mass treatment may begin.

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[1] Page 533.

Hydrophobia

Rabies is a disease of carnivores, especially the dog, the wolf and the jackal. It occurs also in cattle, sheep, pigs, horses and deer. When contracted by man it is termed Hydrophobia. The way of transmission is by the bite of a rabid animal, by the contact of its saliva with a wound or abrasion, or through an unbroken mucous surface. Most human cases are infected by dog bite. The causal agent, a filter passer, is present in the saliva of a rabid animal 3 days before signs of illness are shown. The greatest risk is from bites about the face and head. In Trinidad and Jamaica paralytic rabies is conveyed to man by vampire bats of the genus *Desmodus*.

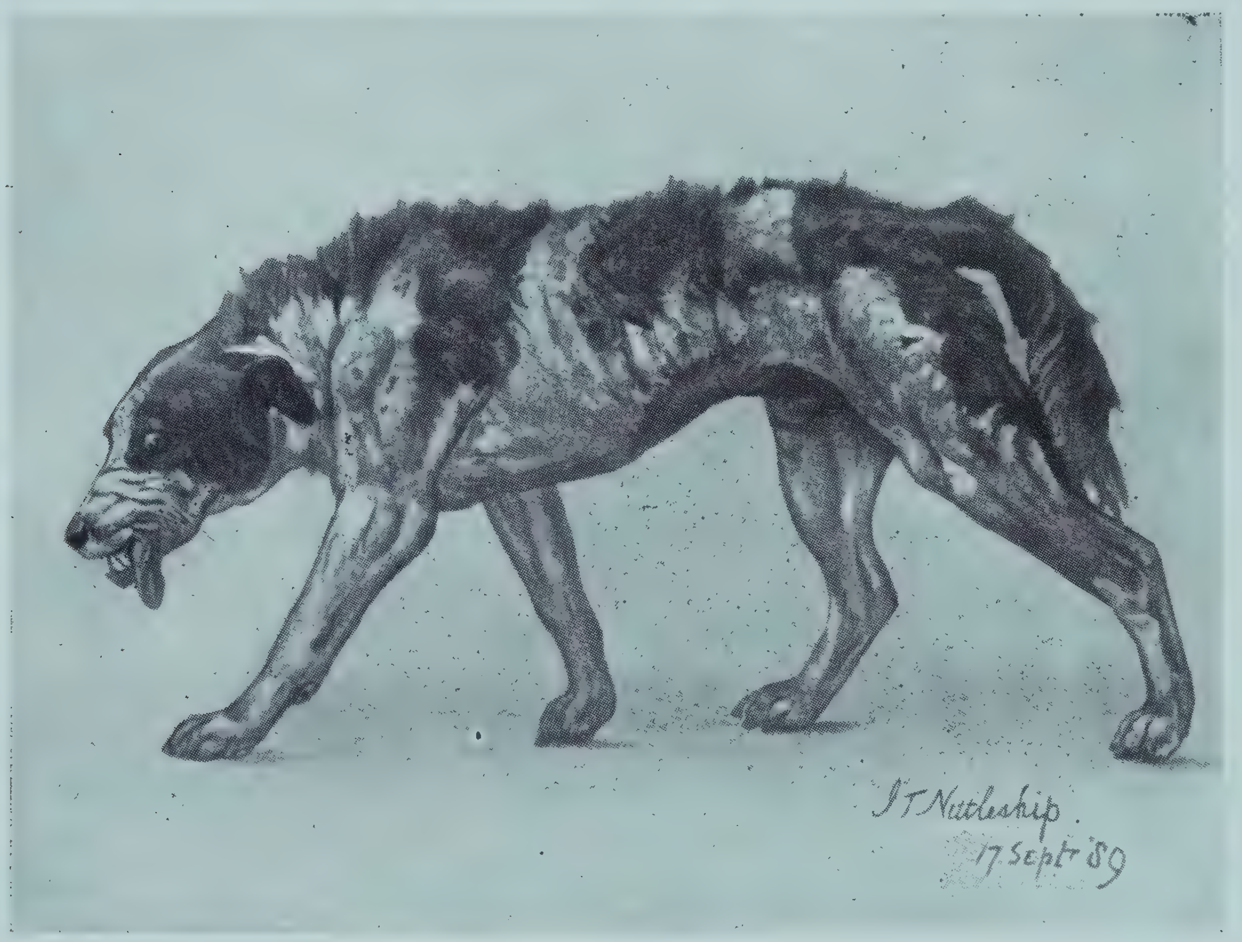

Fig. 112.—Rabid Dog.

The incubation period of hydrophobia in man is on an average 6 weeks from the bite, but ranges within wide limits. The premonitory signs of the rabid type of the disease are pain in the wound or scar and along the nerves of the part. Nervous irritability then sets in with spasm of the muscles used in swallowing and breathing. Next comes a period of paralysis, convulsions and coma. Death results in 4 to 8 days from onset. In the paralytic type there is high fever, ataxia and paralysis, with death in a week.

A dog under suspicion of being rabid (Fig. 112) should be watched in isolation for 10 days. If rabies does not develop within that time, any people it may have bitten need have no fear. If on the other hand rabies shows before the 10 days are up, the people should at once be put under antirabic treatment. Other dogs bitten by a rabid animal should be quarantined for three months.

The long incubation of hydrophobia suggested to L. Pasteur the possibility of making infected persons immune before their seizure developed. By passing through rabbits the natural or street virus he prepared an intensely virulent fixed virus, which he then reduced to successive degrees of attenuation by drying the spinal cords of rabbits, which contained it, over caustic potash for appropriate periods. He began the treatment of his first case, an Alsatian boy named Joseph Meister, by injecting on 7th July, 1885, an emulsion of a cord which had been dried for fourteen days, and continued with a stronger virus daily thereafter, till he reached on the tenth day nearly fixed virus strength, so rendering the boy immune to an infection many times stronger than that of natural rabies. The course had been begun on the third day after the boy received his fourteen bites, and he did not take the disease. Pasteur's second case, the gallant J. B. Jupille, who had his first injection on the sixth day after being bitten, also escaped death. His third case, the little girl Camille Pelletier, did not come under treatment till the thirty-seventh day after she had been bitten. This interval unhappily proved too long and she died of hydrophobia.

The antidote now given is a modification of Pasteur's original attenuated virus. In Semple's method it is a killed fixed virus preserved with carbolic acid. An anti-rabic serum is now available and should be employed in conjunction with the Pasteur treatment.

A person bitten by a rabid or suspect dog should at once consult a doctor and then inform the police. The doctor should immediately cauterise the wound with pure carbolic acid or the actual cautery. The police should report to the Ministry of Agriculture and Fisheries, who will cause the dog's condition to be diagnosed and will inform the Medical Officer of Health whether the person bitten ought to undergo antirabic treatment. If he ought, the Medical Officer will make arrangements for his admission to an antirabic institute, several of which have been established in Great Britain.

A person in charge of a rabid or suspect dog should inform the police, who must transmit the information to the Ministry of Agriculture and Fisheries. The Ministry will investigate the facts and cause the dog's condition to be diagnosed. The post-mortem evidence of rabies in the dog is the presence of the Negri bodies in the hippocampus major or in the Purkinje cells of the cerebellum. It is confirmation if the subdural injection of a suspension in saline of the medulla or cord of the dog produces paresis and subsequent death in a rabbit.

With a view to preventing the introduction of rabies all dogs imported into this country are required to be kept in strict quarantine for 6 calendar months.

Infective Coryza

The causal agent of infective coryza, or 'common cold,' is an ultramicroscopic virus, perhaps kindred to that of influenza. Several strains of the virus are believed to exist. *Passage* through susceptible persons may markedly enhance the virulence of the pathogen. The syndrome is introduced by a sense of chill, or by rigor, then come malaise, engorgement of the rhino-faucial mucosa, nasal discharge, anorexia and fever. These effects are most often due to the presence in the throat or nose of secondary organisms such as streptococci, pneumococci and *H. influenzae.* The attack varies in length from a few days to a few weeks. Amongst predisposing factors are overcrowding and chilling of the body. The immunity conferred by an attack is very transient.

The patient should stay in bed for the first few days, thereby diminishing the risk of transmission. Aspirin and phenylisopropylamine are of service in treatment. Catarrhal vaccines, which contain pneumococci, streptococci and staphylococci, together with *H. influenzae, B. Friedländer* and *N. catarrhalis,* are used in prophylaxis, but tend to be capricious in action. They are in any case effective only against the secondary bacterial invaders. Three doses, of 0·5 ml., 1·0 ml. and 1·5 ml., with a week between, is the usual course. Frequently recurring coryza may in time lead to eustachian catarrh and so to deafness. It lowers vitality and may induce mental depression. Deflection of the nasal septum and enlargement of the turbinals predispose to attack and should receive surgical attention.

Free ventilation of halls of assembly, treatment of the air of public rooms and vehicles with disinfectant in a de Vilbiss spray and public education in the use of handkerchiefs and the suppression of coughing and sneezing are adjuvants of community prevention.

Infective Jaundice

This disease, which bears the further alternative names of Weil's disease and Spirochaetosis icterohaemorrhagica, is known in Europe, Egypt, the Sudan, Malaya and North America. It is specially prevalent and fatal in Japan. It occurs in sewer men, agricultural labourers, rice planters, miners and other persons whose occupation exposes them to contact with rats. On the Western and Italian fronts during the First World War it prevailed in trenches on both sides of the line. In 1922 it was contracted by a seaman who fell into the Thames at Gravesend. It appeared in 1923 among miners at Tranent, and in 1933 in the Northumberland and Durham coalfields. Cases have been observed among fish workers in Aberdeen.

The pathogen, *Leptospira icterohaemorrhagiae,* is a common parasite of the rat, which has acquired a natural immunity to it. Infected rats excrete leptospirae in their faeces and urine. Water or mud contaminated from these sources acts as the vehicle of infection to man, the organism invading either by way of the mouth or through the broken or unbroken skin. Dogs also suffer from spirochaetosis due to *L. canicola,* which is in rare cases also responsible for jaundice in man.

The illness in its typical form shows a sudden onset with malaise, vomiting, myalgia, prostration and high fever. Jaundice, often intense, follows in 50 per cent. of the cases, and may be accompanied by renal insufficiency and purpura. There is invariably a leucocytosis, *during* the febrile phase of the attack, and meningeal symptoms are present in some 10 per cent. of the cases. Mild attacks in which symptoms are latent, and influenzal forms also occur.

Laboratory diagnosis is established by injecting 5 ml. of the patient's blood into a guinea pig during the first week of illness. In positive cases, the animal dies in 8 to 12 days from haemorrhagic jaundice. Agglutinins are present in the patient's blood after the fifth day and a titre of 1 in 30 may be taken as diagnostic. An anti-leptospiral serum is available for treatment. Penicillin is now on trial and appears to be effective against the leptospira.

The prophylactic is rat suppression, particularly in fish and offal factories. The disinfection of water and furniture in such premises with 1 in 60 hypochlorite solution has been recommended. Sewer men and other workers exposed to the infection should be given protective clothing and be instructed in precautionary measures. Protective inoculation with killed leptospiral cultures is still on trial.

Influenza

The use of the name Influenza dates from 1741 but the disease itself is undoubtedly older and possibly of high antiquity. In 1510 the infection passed from Malta to Italy and swept Europe 'not missing a family and scarce a person.' This was the first of four pandemics recorded in the sixteenth century.

The contagium of influenza is a filter-passing virus of which types 'A' and 'B' are recognised. *Haemophilus influenzae* (Pfeiffer) is a secondary invader, as are also the pneumococcus and various streptococcal strains. As the immunity conferred by an attack is fugitive, populations in general are highly susceptible to influenza, the infection of which in time of epidemic spreads with extreme rapidity. The incubation period is one to three days and the initial symptoms are headache, malaise, fever and respiratory catarrh, together with muscle pains. Several distinct influenzal syndromes have been described, designated respiratory, gastro-intestinal, nervous and the like, but many cases do not fall within any clearly defined category. Bronchopneumonia is a grave and often fatal complication. Twice within living memory the disease has swept the world. In the last pandemic, that of 1918-19, 150,000 people lost their lives in England. During such visitations countless persons, including whole families, are prostrated simultaneously, and need arises on every hand for medical attendance, hospital treatment, home nursing, the provision of food and supplies, and the removal of the dead. Four-layer gauze masks should be worn by doctors and nurses attending the sick. When influenza threatens, local authorities should prepare schemes in advance, designating public halls as emergency hospitals, and otherwise concentrating on measures for the relief of distress. Active immunisation by means of formolised virus has given good results in susceptible lower animals, but is still in the experimental stage in so far as man is concerned. Treatment of the air of public halls, cinemas and the like by a spray-produced mist of hexylresorcinol in propylene glycol is claimed to be preventive of infection. Sulphonamides are powerless against the virus, but are of service in combating the pneumonic complication.

Leishmaniasis

This term is applied to three kindred infections occasioned by *Leishmania donovani*, *L. tropica* and *L. brasiliensis* respectively.

Leishmania donovani (Fig. 113), is the pathogen of kala azar, known also as tropical splenomegaly or Dum-Dum fever, and prevalent in India, Africa, China and the Argentine. Kala azar is a chronic disease attended by fever, cachexia, anaemia and enlargement of the spleen and liver. The case mortality exceeds 80 per cent. Diagnosis is confirmed by demonstrating the parasites in Leishman-stained films of liver or spleen juice, obtained by puncture. The aspirating needle should be dry. The psychodid fly, *Phlebotomus argentipes*,[1] is the carrier of the infection from man to man.

Leishmania tropica is the causative agent of oriental sore, tropical sore, Delhi boil or Biskra boil as it is variously called. This lesion is an indolent ulcerating granuloma which occurs on exposed parts of the body and may last for many months. *Phlebotomus papatasii* and *P. sergenti* are the probable vectors.

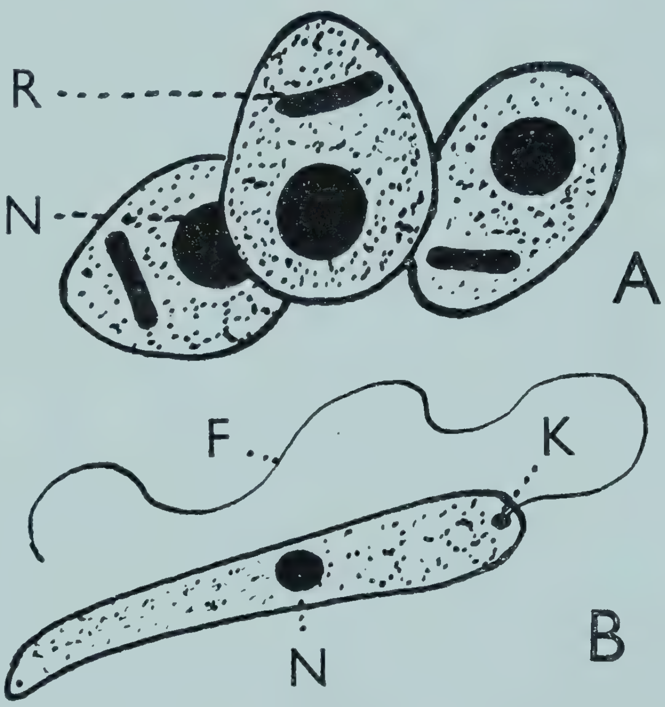

Fig. 113.—Leishmania donovani (greatly magnified).

A. From Liver Juice. *N*, nucleus. *R*, parabasal body.

B. Leptomonas form. *N*, nucleus. *K*, kinetoplast. *F*, flagellum.

Leishmania brasiliensis is the name given to the Leishman body recovered from the fungating ulcers of espundia, known also as uta and forest yaws. The lesion is severe and intractable, slowly destroying the tongue, palate and nose, and in many cases resulting in death from starvation. Espundia prevails in Brazil and other countries of South America. It has been suggested that the insect vector is *Phlebotomus lutzi*.

The specific treatment for all the forms of Leishmaniasis is antimony, given as the tartrate, in 2 per cent. solution, or in organic combinations such as neostibosan or urea stibamine. For the tropical sore and the ulcers of espundia, carbon dioxide snow, x-ray treatment or powdered tartar emetic are in many cases curative.

Control measures are directed to the suppression of the psychodid vector.

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[1] Page 551.

Leprosy

Originally an Oriental malady, leprosy appears to have been recognised in Greece about 400 B.C. It was disseminated in Italy by Pompey's troops disbanded in 62 B.C. after the Eastern war. During ensuing centuries it advanced over Europe, and at the beginning of the Middle Ages had become a common disease. Amid the turmoil of the Crusades the infection extended to all classes of society and reached its climax in the twelfth century. During the fourteenth century it began to decline, disappearing from cultured Italy first. By the seventeenth century it had vanished from Europe, excepting Russia, Norway, Iceland and isolated foci in other countries. It now occurs mainly in India, Central Africa and China, and to a lesser extent in the Philippines.

The pathogen of leprosy is the acid-fast B. leprae (*Mycobacterium leprae*), which resembles *B. tuberculosis.* The infective power of the organism is low. The disease only spreads from person to person under conditions of close propinquity and prolonged exposure. Children are more susceptible than adults.

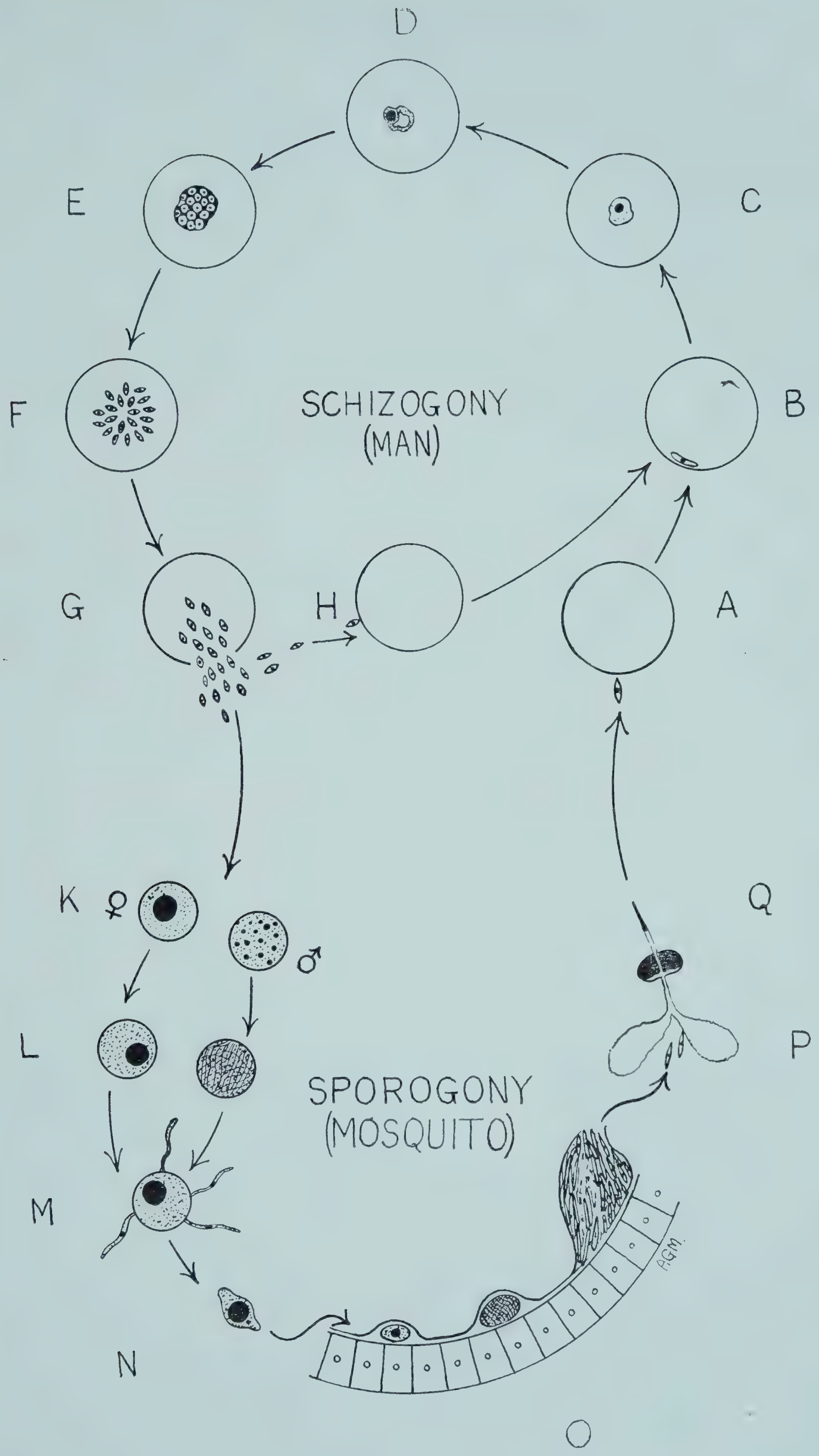
After its prodromal and macular stages, leprosy presents itself in two principal forms known as 'nodular' and 'anaesthetic,' the former presenting the leonine facies, the latter implicating the peripheral nerves. Mixed leprosy occurs when nodular changes are present along with involvement of nerve trunks.

The treatment of leprosy with chaulmoogra oil is now superseded to some extent by the use of the ethyl esters of *Hydnocarpus wightiana,* a plant which grows wild in the leprosy districts of India. 'E.C.C.O.,' compounded from the ethyl esters of the oil together with creosote, camphor and olive oil is beneficial when injected hypodermically. Potassium iodide also plays a part in treatment, but may provoke severe reactions. Encouraging results have recently been obtained from the use of diaminophenyl-thiazolesulphone, a sulphonamide derivative.

In the control of leprosy the custodial lazaretto is rapidly being displaced by the modern leper settlement, organised with its hospital, out-patient dispensary, school, recreation hall and workshops for occupational therapy. The rehabilitation of the patients is a primary object, especially in the case of leprous beggars who are too disfigured to earn a livelihood in the normal world. Remote places may be served by mobile laboratories, which are motor vans carrying a diagnostic outfit, a stock of drugs and, for propaganda purposes, handbills and booklets in native tongues, placards and sometimes a cinematograph projector.

Malaria

Malaria was a common disease of Britain till comparatively recent times. There was a wide prevalence in 1657-64 and another in 1667-85. James I. died in 1625 and Oliver Cromwell in 1658 of agues contracted in London. The recrudescence in England of 1917-18, when 330 cases of indigenous malaria were notified, was owing to the return of infected troops from overseas. The general decline of malaria in this country


D
E
C
SCHIZOGONY
(MAN)
F
B
G
H
A
K ♀
♂
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L
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SPOROGONY
(MOSQUITO)
M
N
O
AGM.

Fig. 114.—Life Cycle of *P. vivax.*

A	Sporozite entering erythrocyte.	F	Merozoites.	N	Zygote (ookinete).
B	Border form.	G	Escape of Merozoites.	O	Sporocysts in stomach wall.
C	Amoebula.	H	Second generation Merozoite.	P	Sporozoites migrating to salivary glands.
D	Ring stage.	K,L	Gametocytes.	Q	Sporozoite in proboscis.
E	Segmentation.	M	Fertilisation.		

MALARIA PARASITES. x 2,000

A.—Subtertian Parasite (Plasmodium falciparum)

Fig. 1.—**Subtertian rings.** Note the marginal form and, in one, double chromatin dots.

Fig. 2.—**Quarter-grown parasite.** When seen in the peripheral blood this denotes a severe infection, as it normally occurs in the capillaries of the internal organs. Note discoloration of cell, its irregularity and the pernicious stippling—known also as ‘ Stephen’s ’ and ‘ Christopher’s ’ dots, and also as ‘ Maurer’s dots ’ or clefts.

Fig. 3.—**Schizogonic stage, or rosette form,** with thirty spores, also usually in capillaries of internal organs—seldom seen in peripheral blood.

Fig. 4.—**Male gametocyte** (crescent).

Fig. 5.—**Female gametocyte** (crescent). Showing concentration of chromatin and pigment.

B.—Benign Tertian Parasite (Plasmodium vivax)

Fig. 1.—**Young ring form.**

Fig. 2.—**Quarter-grown parasite.** Note Schüffner’s dots and slight enlargement of corpuscle.

Fig. 3.—**Half-grown parasite.** (Amoeboid form.)

Fig. 4.—**Three-quarter grown parasite.** (Amoeboid form.)

Fig. 5.—**Presporulating stage** showing fragmentation of chromatin.

Fig. 6.—**Complete schizogony.** (Rosette stage with 20-24 spores.)

Fig. 7.—**Male gametocyte.** Note loose arrangement of chromatin and purple tinge of protoplasm.

Fig. 8.—**Female gametocyte.** Note compactness of chromatin and blue tinge of protoplasm.

C.—Quartan Parasite (Plasmodium malariae)

Fig. 1.—**Ring form.**

Fig. 2.—**Quarter-grown parasite** (‘ band form ’). Note corpuscle is not enlarged.

Fig. 3.—**Half-grown parasite** (‘ band form ’). Note the scattered black pigment.

Fig. 4.—**Presporulating stage.**

Fig. 5.—**Complete schizogony.** (Rosette stage with 8-9 spores.)

Fig. 6.—**Male gametocyte.** Note purple tinge of protoplasm with heavy pigmentation.

Fig. 7.—**Female gametocyte.** Note blue tinge of protoplasm. (Blue dots, when present, are known as Ziemann’s stippling.)

Fig. 8.—**Normal red blood corpuscle** for comparison of size.

D.—Ovale Tertian Parasite (Plasmodium ovale)

(After James and Shute.)

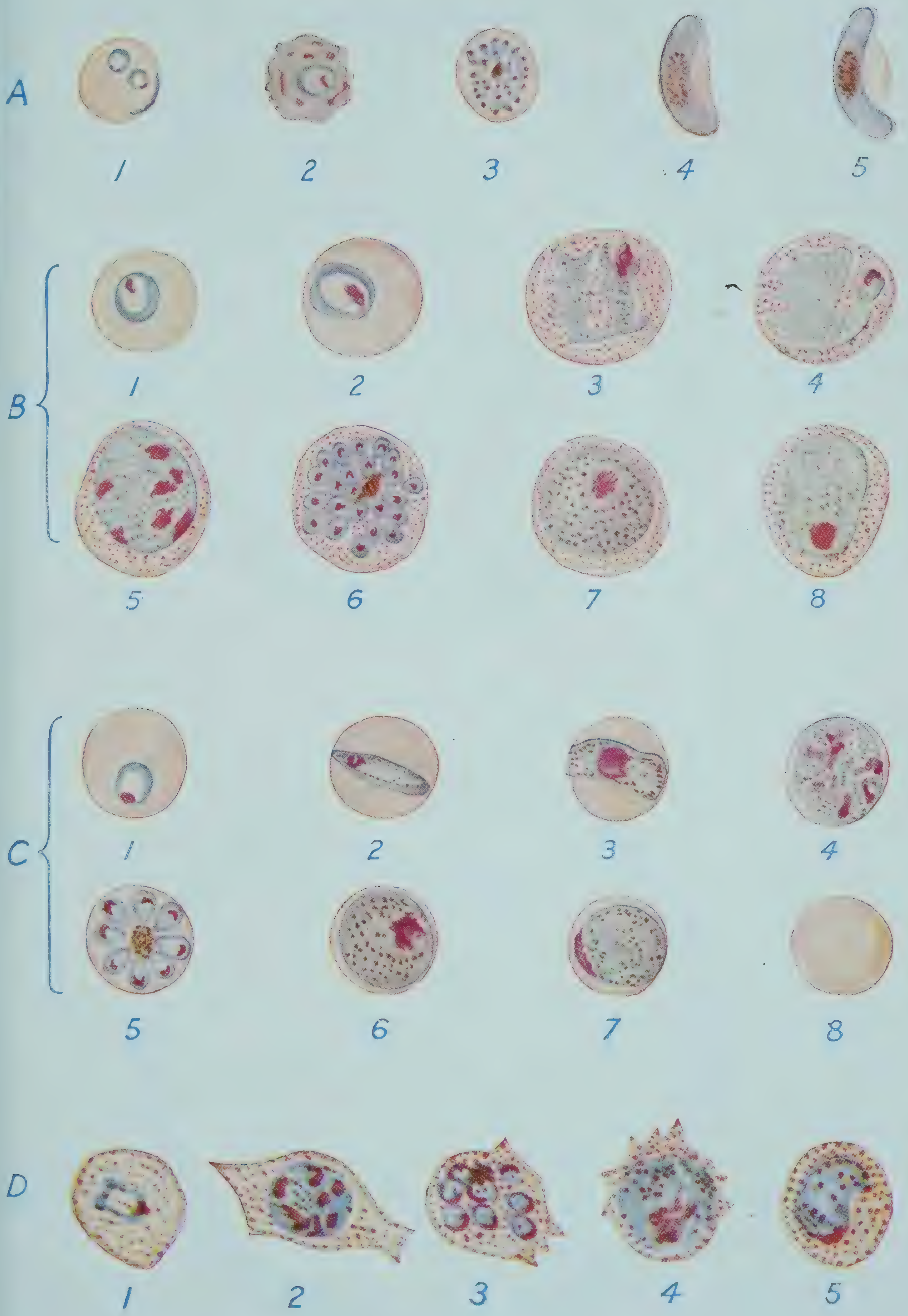
Fig. 1.—**Ring form.** Note Schüffner’s dots.

Fig. 2.—**Presporulating stage.** Note irregular and oval shape of corpuscle with coarse and prominent Schüffner’s dots.

Fig. 3.—**Complete schizogony.** Note irregular distribution and oval shape of spores and also distortion of corpuscle.

Fig. 4.—**Male gametocyte.** Note coarse Schüffner’s dots and purple tinge of protoplasm.

Fig. 5.—**Female gametocyte.** Note marginal arrangement of pigment.


A
1
2
3
4
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B
1
2
3
4
5
6
7
8
C
1
2
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6
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D
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4
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Fig. 115.—Malarial Parasites.

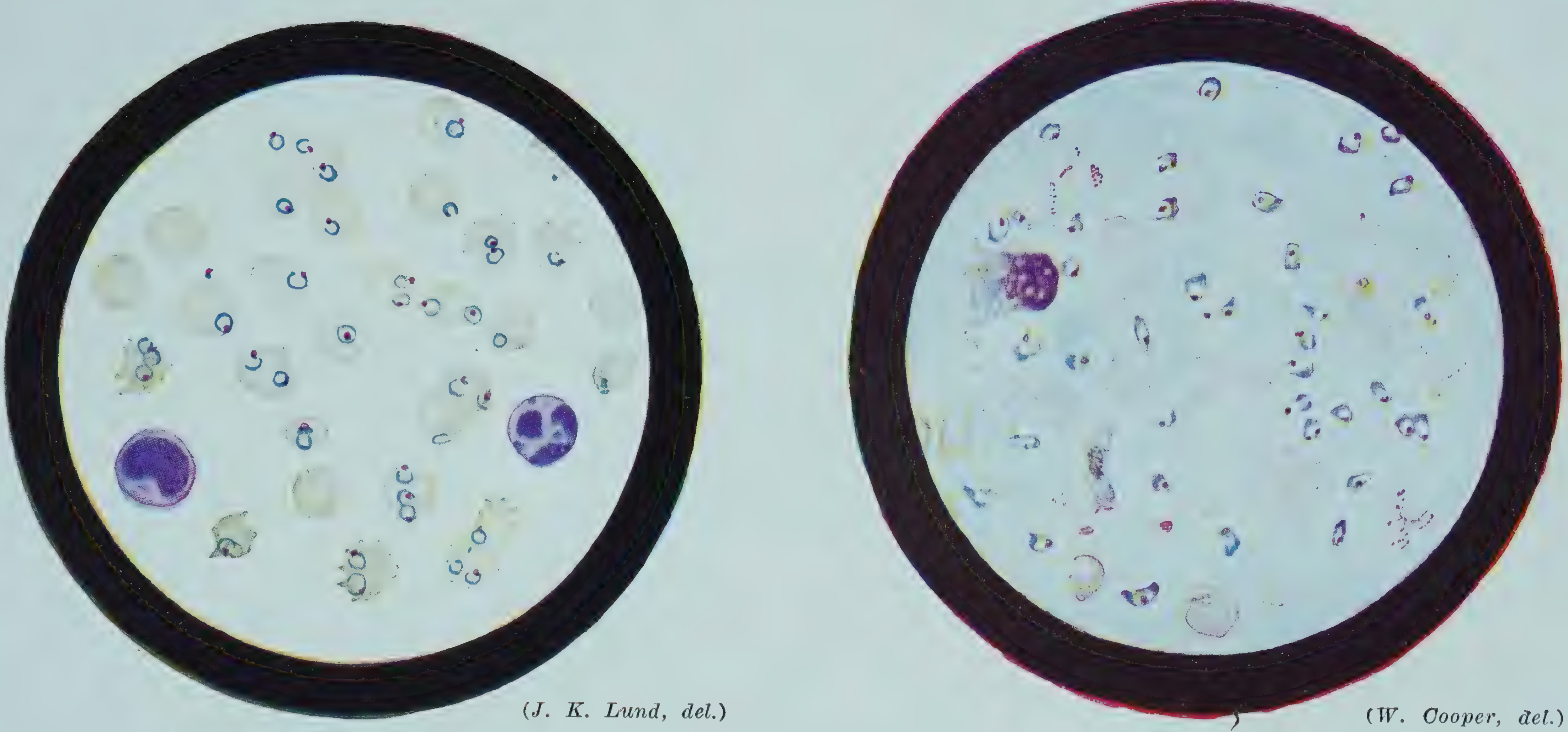
is to be ascribed to the steady influence of land drainage in reducing mosquito prevalence.

The disease occurs in every continent, ranging from Lake Ladoga in 60° N. to Southern Queensland, the South of Natal and the Southern boundary of the Argentine Republic. Its major incidence is tropical and subtropical. It is caused by the presence in the blood of specific haemosporidia of the genus Plasmodium of which there are four main types. *P. vivax* and *P. ovale* are responsible for benign tertian fever, *P. falciparum* for malignant tertian fever while *P. malariae* is the infective agent in quartan fever.

Man is the intermediate host of the haemosporidium which completes its sexual cycle (Fig. 114) within the body of a mosquito of the genus Anopheles. Some thirty species are known to carry the infection. The plasmodium undergoes a non-sexual cycle in human blood, invading the erythrocytes and causing their destruction. A toxin elaborated by the parasite, being diffused when the blood cell ruptures, gives rise to the paroxysm of fever. The clinical picture of malaria is produced by a sequence of cold, hot and sweating stages. The train of symptoms in the typical case is as follows. After an incubation period which averages 10 days, the attack begins with malaise, chilliness and sudden severe rigor. Child patients may develop convulsions. An hour or so later, the hot stage is ushered in with flushed face, violent headache, dry burning skin and pyrexia which may reach 105° F. or higher. The fever lasts for three to four hours, when it is terminated by profuse perspiration, after which the patient sleeps. He then remains symptom-free for one, two or three days, depending on the type of the parasite. The cycles of the various species, together with the respective blood pictures, are summarised in the text to Fig. 115. Malignant tertian fever is in general more severe than the others and its stages are often less well defined. It may also be complicated by jaundice. Cerebral, hyperpyrexial and pneumonic varieties of the infection occur, particularly in the tropical zone, and are often fatal. Invasion of the suprarenals by the parasite produces algid malaria attended by subnormal temperature, lowered blood pressure and collapse. Complications of malaria include dysentery, nephritis and rupture of the spleen. Neuritis and melancholia are recognised sequelae. Two generations of parasites may be found in one individual, giving rise to daily fever, and two or more types of parasite are not infrequently present. Relapses are a feature of the disease and occur most commonly in quartan fever. They may be initiated by exposure and excesses.

The diagnosis is confirmed by finding the parasites in thick or thin films of peripheral blood, stained by Leishman's, Giemsa's, or Field's brilliant-cresyl-blue method. It may be necessary to examine films on several consecutive days.

The standard treatment as employed in the British Army begins with 10 grains of quinine bisulphate thrice daily for the first and second days with a saline purge following the first dose of quinine. From the third to the seventh day the drug employed is mepacrine hydrochloride, one 0·1 gram tablet thrice daily. The eighth and ninth days are free.



(J. K. Lund, del.)

Blood-film from fatal case of subtertian malaria, showing heavy "ring" infection. (*Giemsa's stain.*)

(W. Cooper, del.)

Thick blood-film preparation of subtertian rings and crescent stained by Leishman to show appearances after dehaemoglobinization. x 1,000. (*From a preparation by Dr. H. Seidelin.*)

Fig. 116.—The Blood Picture in Malignant Tertian Malaria.

From the tenth to the fourteenth day there is a thrice-daily 0·01 gram dose of pamaquin. Diet is fluid and the patient is kept in bed during the febrile phase. In heavy infections, and in urgent cases, quinine may be administered by the intramuscular or intravenous route. Mepacrine and pamaquin are the British equivalents of the synthetics atebrin and plasmoquine respectively. Mepacrine kills the schizonts. Pamaquin is gametocidal. A new synthetic, Paludrin, is still on trial.

For the prophylaxis of malaria the two main lines of action are (1) as regards the human subject, to cure the sick of their malaria, treating them meanwhile under mosquito-proof conditions, and (2) as regards the mosquito, to adopt effective measures of mosquito control.[1] A daily 6-grain dose of quinine bisulphate, or alternatively a bi-weekly 0·2 gram dose of mepacrine, serves as a malaria suppressive. The bi-weekly dose should be increased to 0·3 gram in areas of heavy endemicity.

The disease condition known as Blackwater Fever occurs in malarious zones, and malaria appears to play an essential part in its causation. It is rare in native populations. Undue heat or cold or alcoholic excess may initiate the attack. Malaise, headache, lumbar pain, asthenia and haemoglobinuria constitute the syndrome. Fatal, toxic and anuric varieties of the fever are also encountered. Treatment is mainly symptomatic. Co-existing malaria should be cautiously treated with mepacrine. The measures designed to eradicate malaria are preventive of blackwater also.

Measles

Measles appears to have been recognised by the Arabs, who, however, regarded it as akin to smallpox. The London prevalences of 1671 and 1674 were described by T. Sydenham. During the nineteenth century there were five periods of major severity in Britain. The disease is of wide distribution, especially in temperate climates. It shows peaks of incidence in June and December. The contagium is a filter-passer which exhibits high virulence when implanted in non-immune populations. The infection is known also as Morbilli and Rubeola.

The onset of measles is with sneezing, laryngitis, a brassy cough, running at the nose and eyes and photophobia. An early sign is the presence of the characteristic though often transient Koplik's spots, minute bluish-white specks which may be seen on the gums and inside the cheek but not on the palate. The rash, which shows on the fourth day, consists of carmine blotches slightly raised above the skin and velvety to the touch. The appearance of the face is distinctive in the acute stage. Bronchopneumonia, complicating the original attack, and due to streptococcal invasion, is a common cause of death. Another important complication is otitis media. Conjunctivitis and panophthalmitis also occur, the last happily infrequent, and meningo-encephalitis has been reported. The case mortality ranges between 2 and 6 per cent. The most fatal years are the first and second. Incidence is highest at ages under 5, particularly in slum populations.

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[1] Page 553

Treatment is symptomatic. Sulphonamides have been found of service in the prevention and treatment of respiratory and aural complications.

The infection of measles, which is spray-borne, is most active in the pre-eruptive stage before the disease is commonly recognised. General notification, including all cases, is therefore of little value to prevent the spread of the disease and, where adopted, has usually been abandoned, but the notification of the first case in households has proved of service, since the early removal to hospital of ensuing ill-housed or serious cases prevents the onset of the pulmonary complications or mitigates their severity. Under war conditions, however, the general notification of measles has been prescribed by regulations for England and Wales on two occasions: namely (1) during the First World War, from 1915 to 1919, and (2) during the Second World War, from October, 1939. In many areas, when measles becomes epidemic, it is the practice to give measles cases priority of admission to hospital over scarlet fever. During an outbreak health visitors and nurses should be detailed for special measles duty. The closing of schools is powerless to check a rising epidemic.

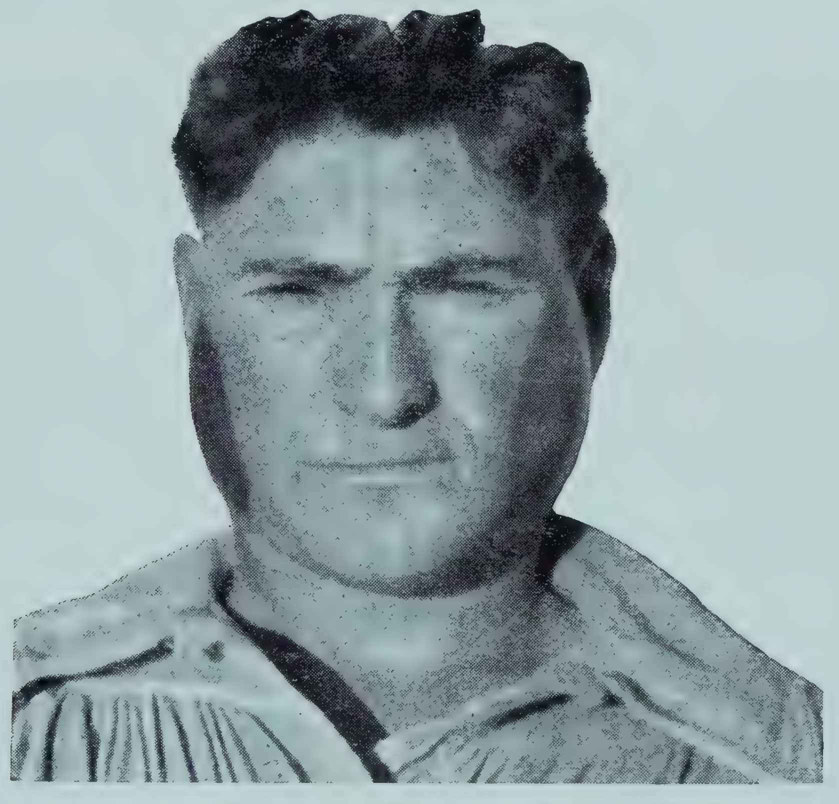

Fig. 117.—Mumps.

The occurrence of measles can be prevented in children exposed to infection by injecting within 3 days of exposure, by the intramuscular route, 5 to 10 ml. of 'convalescent serum,' that is to say, the blood serum of a Wassermann-negative person who has recovered from an attack. The immunity so conferred is passive and lasts up to a month. An injection of half the usual dose of convalescent serum is nowadays given with a view to allowing a mild attack of measles to develop and so confer active immunity. Alternatively the full dose may be withheld until the fifth day after exposure. This practice should not however be followed in the case of weakly children or in those under the age of two years. Less valuable immunising agents of the same type are 'adult serum' and 'placental extract globulin.'

Depots for pooling convalescent serum should be established in all large centres of population.

Prophylaxis on general hygienic lines consists in raising the standards of housing and nutrition.

Mumps

The enlargement of the parotid gland which distinguishes Mumps, or Infective Parotitis, lifts the ear and gives the face a whimsical appearance (Fig. 117). The swelling is tense and tender, but the skin over it remains pale. It is at first unilateral, passing later to the other side. Trismus is well marked during the attack and pain may be felt at the angle of the jaw before swelling appears. Lymphocytosis beginning after the third day of illness and lasting for a couple of weeks is a constant feature, which serves to differentiate mumps from a septic parotitis. Among adolescents, as a metastatic complication, orchitis occurs in some 16 per cent. of males, and mastitis or oophoritis in a smaller proportion of females. The affection is mainly one of childhood and adolescence.

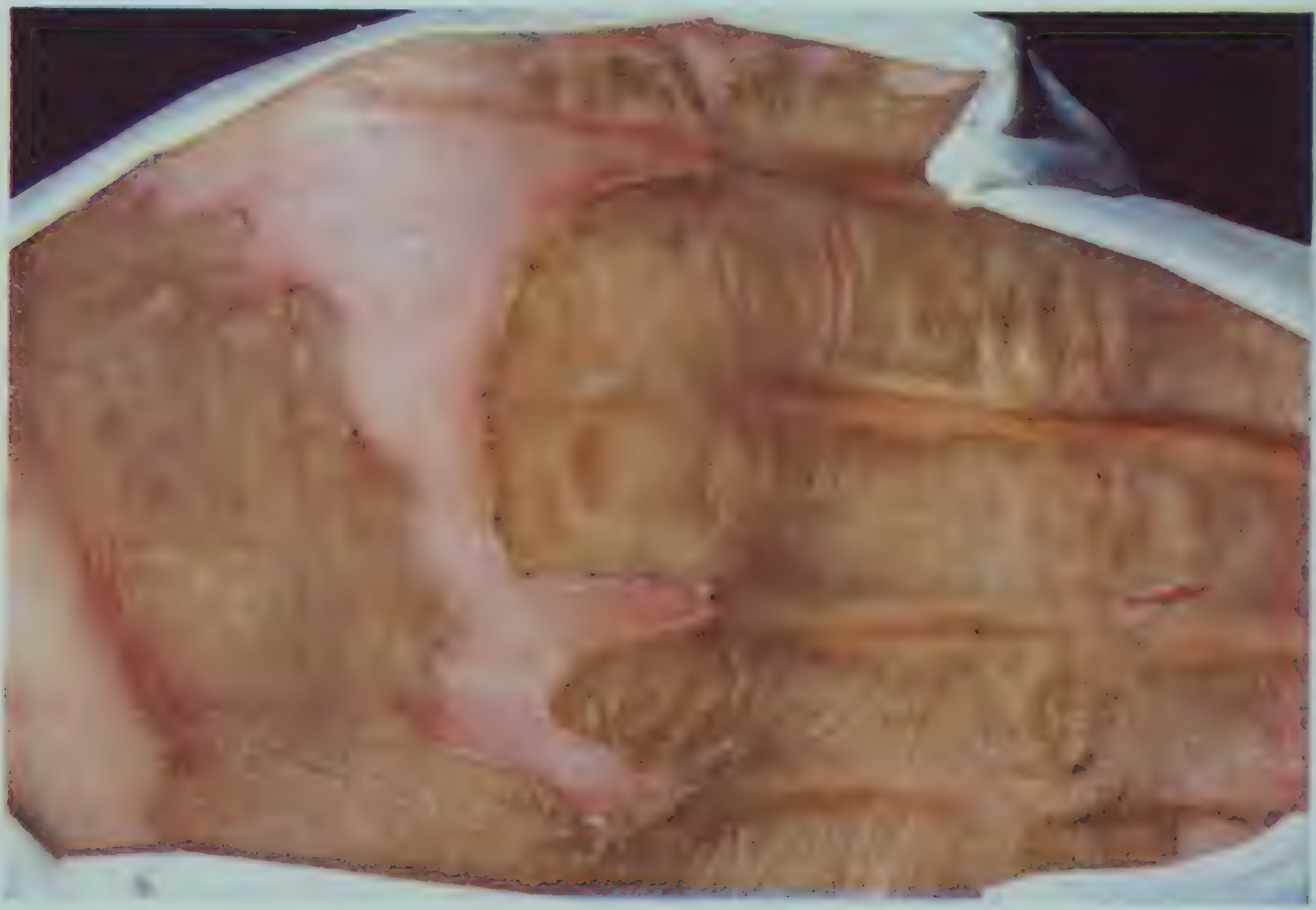

Fig. 118.—Pellagra.

The contagium, which is a filter-passer, is received and transmitted by way of the mouth, entering the salivary glands by Stenson's and Wharton's ducts and returning in the saliva. The infectivity rate is high and the incubation period from seventeen to twenty-six days.

Treatment should begin with a purge. Mouth washes may be used and hot fomentations applied to the swollen parotids. All patients at or near puberty should be kept in bed for 10 days. It is claimed that the blood serum of convalescents confers immunity. As a therapeutic measure it is worth a trial in adolescents, on account of the complications to which they are liable.

Pellagra

This affection may run an acute, chronic or remittent course. The typical erythema, mainly affecting extensor surfaces, usually appears in spring. Later the skin may assume the consistency of parchment and exfoliate or form crusts (Fig. 118) with suppuration beneath. Evidences of digestive derangement are flatulence, redness and desquamation of the tongue with a burning sensation in the mouth, and in later stages persistent diarrhoea. In chronic cases the central nervous system becomes deeply involved, as shown by insomnia and delusions leading on to melancholia or suicidal mania. Spastic paralysis of a type suggesting subacute combined degeneration of the cord is of frequent occurrence.

Pellagra is endemic in the maize-eating districts of Italy, the Balkans, Egypt and the southern United States, and cases are reported in England from time to time. The disease ranks as a member of the multiple-deficiency group, as noted under vitamin P-P above.[1]

It is not certain to what extent pellagra is a disease unity. It seems however to be more or less established that it has some connection with maize. Treatment is by rest and a varied nutritious diet, including the vitamin B complex.

Plague

Plague, the Black Death of the Middle Ages, is an enzootic due to *Bacillus Pestis* and conveyed to man as a general rule by *Xenopsylla cheopis* or *Ceratophyllus fasciatus*,[2] fleas of rats. In the human subject it appears in the two principal forms of (1) Bubonic and (2) Pneumonic plague. The epidemiology of plague has already been discussed.[3]

Bubonic Plague. In this form the bubos are inguinal in 70 per cent. of cases: axillary in 20 per cent.: and cervical in 10 per cent. The prodromal signs are usually malaise, anorexia and apathy, with inguinal pain. During the attack thirst is intense, the skin parched and the eyes sunken. The temperature may reach 107° F. Later on the mind wanders. Diagnosis is confirmed by demonstrating the bacilli in material obtained by gland puncture. The bubo may vary in size from a walnut to a goose egg and usually suppurates in the terminal phase. The case mortality is of the order of 60 per cent.

Pneumonic Plague. This form is a pneumonia in which the constitutional derangement is out of all proportion to any physical signs discernible in the chest. There is a copious thin blood-stained sputum thronged with plague bacilli. Delirium is again a feature. The case mortality is 98 to 100 per cent.

The specific treatment of plague is by the repeated intravenous injection of Yersin and Lustig's antiplague serum in amounts up to 100 ml., combined with full doses of sulphadiazine or sulphathiazole. Merit has been ascribed also to mercurochrome 1 per cent. given intravenously in 20 ml. doses.

At the present time plague is endemic in India, Africa, China and Irak. It has occurred in every continent, including Australia, being conveyed over the sea routes through the agency of ship rats and overland by freight-car haunting rats. Both the black and the brown rat are inculpated, and other small rodents such as the marmot, gerbille, tarbagan and ground squirrel act as reservoir hosts in various countries. Rat proofing and rat destruction [1] both by land and sea play an essential part in the control of plague. The personal prophylactic is 2 to 4 ml. of Haffkine's vaccine of dead plague bacilli with toxins in solution, administered subcutaneously. The immunity conferred lasts for rather more than a year. The reaction may however be severe. Persons on plague duty should wear flea-proof clothing with puttees and rubber or leather gloves. Nurses in charge of pneumonic plague should have the protection of gauze masks fitted to eye-pieces. A recent improvement is the *Combinaison Hermétique,* an all-rubber suit with zip fasteners and mica face-piece (Fig. 119). Carcases of suspect rats intended for pathological examination should be placed in a linen bag, saturated with paraffin to destroy fleas, and transmitted to the laboratory in a sealed tin box clearly labelled to indicate its contents.

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[1] Page 222.
[2] Page 565.
[3] Page 410.

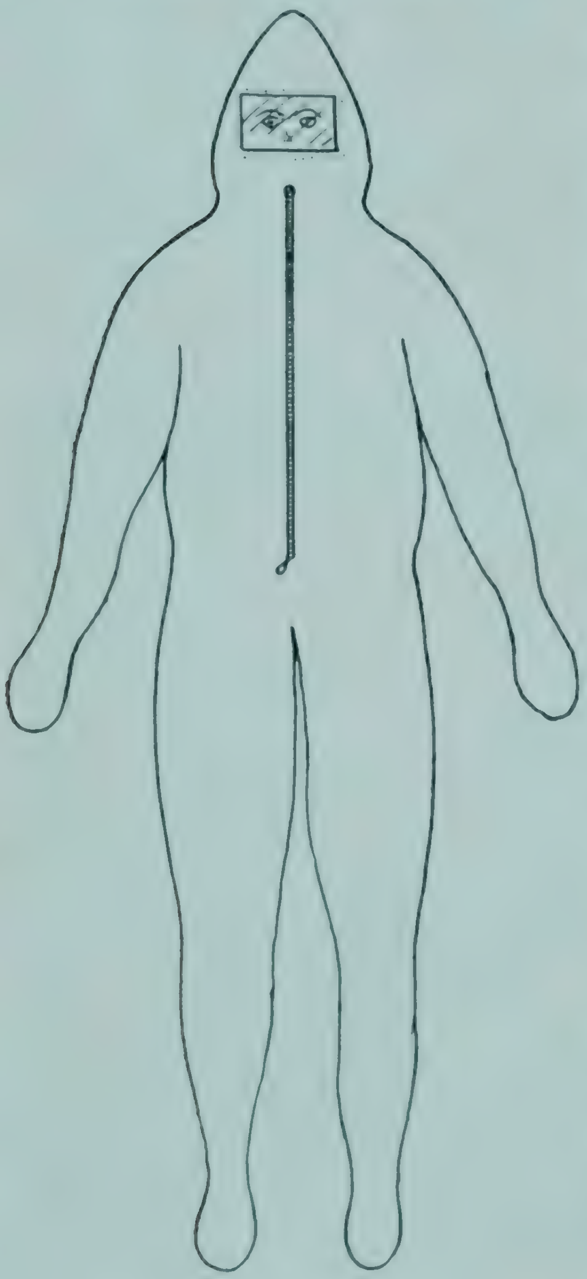

Fig. 119.—Combinaison Hermétique.

Pneumonia

Lobar Pneumonia, known also as Acute Primary Pneumonia, occurs in all climates and attacks all ages. It is most prevalent in winter and spring. The case mortality is 20 per cent. The rate is high in young children under 2, low between the ages of 2 and 10, reaches the average between 20 and 30 and rises progressively thereafter. The specific pathogen in 90 per cent. of cases is the *Pneumococcus* or *Diplococcus pneumoniae* which is readily demonstrable in the sputum. In fatal cases death results from the action of non-specific endotoxins set free by lysis. Infection must be presumed to be spray-borne, usually in the first instance to persons who become carriers, since transmission from case to case is exceptional, though linked grouping is recorded from time to time in overcrowded quarters. Dust-borne infection is regarded as a possibility. Alcoholism and exposure to rapid changes of temperature are predisposing factors.

Of the four varieties of *pneumococcus* identified, Types I and II are found in some 60 per cent. of cases. Type III, fortunately uncommon in this country, has the highest virulence. Group IV includes a miscellany of strains, of low virulence, not agglutinated by the antisera to Types I, II and III, and similar to the pneumococci recovered from the mouths of healthy persons. The modern treatment of the disease is chemotherapeutic, employing sulphadiazine in 2 gram doses four-hourly or sulphathiazole. Temperature rapidly falls under this regime and many lives are now saved. In cases where these drugs are not tolerated, or in which sulphonamide-resistant organisms are present, penicillin is markedly effective. It must not be forgotten that skilled nursing and the administration of oxygen are necessary adjuvants to chemotherapy in severe cases, especially in the aged. Immunisation by means of a polysaccharide antigen prepared from pneumococcal types I and II is now on trial.

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[1] Page 579.

Lobular Pneumonia, also styled Bronchopneumonia, is the term employed to designate a variety of pulmonary inflammations. In its primary form it occurs only in children under three and is due to the *pneumococcus.* In its secondary form, which may occur at any age, it may be due to *Streptococcus haemolyticus, Staphylococcus aurens, H. influenzae* or the Friedländer pneumobacillus. It is a concomitant, or sequela, of epidemic influenza. When the causal organisms are sulphonamide-resistant, penicillin is indicated.

Primary Atypical Pneumonia has come under notice only during recent years. It is apparently due to a virus, suggested to be kindred to that of psittacosis. The onset of the condition is often insidious and its symptoms uncharacteristic. Patchy pulmonary lesions may be discernible under x-ray. Both sulphonamides and penicillin have so far proved ineffective in treatment.

Poliomyelitis

Poliomyelitis was first described by the English physician Underwood in 1784. Heine in 1840 wrote a monograph upon it, and Oscar Medin in 1890 observed its occurrence in epidemic form. The Swedish outbreak of 1881 was a focus from which the disease became disseminated widely over the world. In the United States the infection gathered force during the current century, and culminated in 1916 with a record of 27,363 cases. More than 650 cases were notified in England and Wales during 1942.

Acute poliomyelitis is an infectious fever the causative agent of which frequently though not invariably involves the nervous system. It is known also as Infantile Paralysis, though not peculiar to infant ages. When it chiefly or solely affects the upper motor neuron it is termed Polioencephalitis. The pathogen is a filter-passing virus which when injected into the brain of monkeys reproduces the disease. Infection is by the gastro-intestinal or respiratory tract. The virus has been recovered from the faeces of patients, from the dejecta of house flies and from sewage. It may be conveyed by water or milk. Hot dry summer weather tends to foster epidemics.

The attack of poliomyelitis begins with high fever, coryza, headache and occasionally epistaxis. Children are drowsy but adults usually restless. In its general aspect this stage of onset resembles gastro-enteritis. It is followed by the paralytic stage with its characteristic implication of a group of muscles. The 'spinal sign' of this stage is the pain produced when the attempt is made to bend the spine forward. The paralysis, which is of a flaccid type, shows great variation both in degree and range. It is often preceded by signs of diffuse meningo-encephalitis. The globulin content of the cerebrospinal fluid is increased. Abortive and mild cases are common, and probably constitute the principal means by which the infection is propagated. Carriers also assist. Child contacts should be excluded from school for 2 weeks.

The disease attacks all classes impartially or, where it shows a preference, selects the well-to-do. In England lately it seemed to concentrate upon the great public schools. The case mortality ranges between 10 and 20 per cent. Fifty per cent. of those who escape death are crippled in various ways, and sequelae include permanent muscular paralyses, atrophy of limbs and deformity of joints.

The sick should be isolated in hospital and contacts kept under notice. The mechanical respirator is required when the paralysis attacks the muscles of the chest. The extensive trials made of convalescent serum, whether for prophylaxis or treatment, have been inconclusive. During epidemics swimming baths should be chlorinated. Overcrowding of children in schools, cinemas and play-grounds should be avoided. Soft fruits should be washed in weak permanganate solution, and all milk pasteurised.

For residual paralysis, ambulatory treatment, massage and muscle re-education without fatigue are the proper measures. During the stationary stage, which begins some 2 years after the acute attack, deformities may require to be corrected by the use of plaster, forcible stretching, tenotomy or similar surgical procedures, or function improved by such operations as tendon transplantation or astragalectomy.

Psittacosis

This disease, known also as Ornithosis, affects the Psittacidae, especially those fresh from their native tropics, and to a lesser extent pigeons and domestic fowls. In these birds it manifests itself as an enteritis, preceded by a period of lethargy. The attack is often accompanied by septicaemia, and there may be haemorrhages and intense congestion of the viscera *post mortem*. The specific contagium is a filter-passing virus. The disease may be contracted by man from handling or otherwise taking to do with birds of the parrot class, which comprises, besides the parrot, the budgerigar, cockatoo, macaw and lorikeet. In the human subject psittacosis is attended by headache, fever, vomiting, diarrhoea and frequently broncho-pneumonia. The virus is present in the blood within the first four days of illness. There is some clinical evidence of the efficacy of penicillin in the treatment of the disease. Cases occurring in man in this country have had a mortality of 20 per cent. Outbreaks have been recorded in Paris, Germany and the United States.

Imported birds of the parrot class are subject to quarantine, and, under the Parrots (Prohibition of Import) Regulations, 1930, must be notified to the customs officer by masters of ships coming to a British port. Any sick among them may be destroyed by order of the port medical officer.

Rat-Bite Fever

The pathogen of rat-bite fever is *Spirillum minus*. Diseases of a similar type may follow the bites of cats and ferrets. The incubation period is on an average 5 to 10 days, but it may be prolonged to 60 days. The wound, usually after healing, shows an inflammatory halo, with subsequent blistering or necrosis. The lymph glands of the area enlarge, rigors ensue and the temperature may reach 104° F. After a 3 days' fever the attack terminates in a crisis, which is followed by sweating. Convalescence is normally interrupted by several relapses. Occasionally there is a rash, with muscle-joint pains. The case mortality is 10 per cent. The spirillum is demonstrable in the blood by the dark field technique, and in stained films, during the attack, though it is often scanty.

A single injection of '914' or kindred arsenical suffices to cure rat-bite fever. All bites by rats should be cauterised and an injection of '914' given as a prophylactic.

Relapsing Fever

The fever bearing this name has resemblances to rat-bite fever. Thus its pathogen is a spirochaete: it is conveyed to man through the agency of a bite, in this case of an arthropod: it is, as its title indicates, attended by relapses: and it is remediable by the use of '914.'

The European type of relapsing fever, at one time known also as 'famine fever,' spread widely over the United Kingdom more than once during the nineteenth century. It has now vanished from our country as an indigenous infection, but in Eastern Europe is still liable to occur. Indian, North African and Central African variants of the European form are recognised. Tick-borne fever occurs also in Colorado, Texas, Utah, New Mexico and Idaho. *Ornithodorus turicata, O. hermsii* and *O. talaje* are the American vectors of the fever. The features of the two types of infection are as summarised hereunder:

Type of Fever	Spirochaete	Vector	Incubation Period	Number of Relapses
European.	S. recurrentis.	Pediculus corporis.	5-12 days	1-10
Indian.	S. carteri.	Pediculus corporis.	5-12 days	1-10
North African.	S. berbera.	Pediculus corporis.	5-12 days	1-10
Central African.	S. duttoni.	Ornithodorus moubata.	2-6 days	2-3

Following an incubation period of one week, the onset of the fever is acute, with rigors. There is nausea, vomiting, epistaxis and lumbar pain. Jaundice complicates the attack in 50 per cent. of the cases. Each attack subsides by crisis, with profuse sweating. The Central African variety of the infection tends to be more severe than the others.

The pathogen is demonstrable in the blood stream during the febrile stage both by dark-field examination and in stained blood films.

The bug may lend its aid to the louse in conveying European relapsing fever to man but does not appear to originate outbreaks on its own.

Delousing[1] and anti-tick measures are prophylactic. Persons at risk may be protected by giving them '914.'

Rheumatism

There are grounds for the view that this disease is an infective process which is for the most part dormant in the body, but assumes on occasion the acute form as an attack of arthritis, chorea or endocarditis, or else develops as subcutaneous nodules, erythema or pleurisy. There is however no general consensus as to the identity of the specific contagium. A haemolytic streptococcus has been regarded as the most likely pathogen but there is little evidence of direct transmission from person to person. Expert opinion now tends to discredit the view that it is primarily psychogenic. The case for focal sepsis as an aetiological factor is far from being proved.

Rheumatism runs in families. It affects the artisan classes more than the poor or the well-to-do. It is favoured by cold and damp, whether of climate, house or locality. It has a high incidence in the metal and other trades and, in one of its forms, among miners. It is one of the indigenous diseases of this country.

The acute variety of the disease, known as rheumatic fever, may be conveyed by droplet infection and is most common in children and adolescents. It frequently occurs some two weeks after an attack of streptococcal tonsilitis. The illness shows peaks of incidence in the first and last quarters of the year and a peak of mortality in the eighth year of life. The disease tends to recur, and each attack is fraught with greater danger than the one before.

The heart lesion dominates rheumatism. It has been demonstrated in the infant. It culminates about the age of 10. Among the early evidences are lassitude, irritable heart and disturbance of rhythm, followed by acute, subacute and chronic dilatation. Breathlessness and valvular signs belong to later stages. Chorea is generally regarded as a nerve manifestation of the rheumatic infection. It may co-exist with the rheumatic heart lesion. School children found at medical inspection or otherwise to present these indications may be placed under observation in special schools or dealt with in convalescent hospitals or residential hospital schools. Supervision in centres at general hospitals has yielded good results.

In the management of the rheumatic case a good hygienic environment is essential. Sudden changes of air temperature, which influence the body temperature, should be avoided. Food should be plain and nutritious and clothing warm. Adequate sleep is essential. Prolonged rest in bed is required both for carditis and for chorea. There is evidence that daily doses of, say, 1 gram of sulphanilamide throughout the winter months is preventive of relapse in children who have had rheumatic fever, and protective against recrudescences of the rheumatic syndrome following dental extraction or tonsillectomy. A search for streptococcal carriers in the homes of cases is of importance in this connection. Focal sepsis should be treated with a vaccine, the injections being widely spaced lest a sharp reaction occur. Other adjuvants are hydrotherapy, massage, local heat and colonic lavage. Though psychological factors are rarely a primary cause of the disease the possibility of a psychogenic approach should be considered for cases in which all other forms of treatment have proved ineffective.

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[1] Page 541.

Enucleation of the tonsils has been regarded as prophylactic of rheumatism. The evidence as to its efficacy for this purpose is however conflicting. In some cases it may light up a latent focus. On existing information the right procedure with the tonsils would be, if on account of their septicity or other untoward state they call for removal irrespective of rheumatism, to remove them: otherwise not.

Among other lesions which in the meantime are classed as members of the rheumatic group are fibrositis, pleurodynia, torticollis, lumbago, sciatica, brachial neuritis, rheumatoid arthritis and osteoarthritis. They occasion an amount of suffering and incapacity, especially among industrial workers, which is not only regrettable in itself, but entails serious economic loss. In England and Wales during a recent year the expenditure under the National Insurance Scheme on sickness and disablement benefit for incapacity ascribed to rheumatism was close on £2,000,000. In Scotland, during the year 1938, new cases of incapacity due to the rheumatic disability exceeded 45,000 and upwards of 3,000,000 working days were lost.

Community measures for the amelioration of rheumatism, as recommended by the Rheumatism Sub-Committee of the Department of Health for Scotland, include a regional scheme for rheumatic treatment, based on the teaching hospitals and linked with intensive laboratory and social research, the institution of peripheral clinics for physiotherapy and follow up work and the promotion of post graduate courses in rheumatism for medical practitioners. It is suggested that provision should be made, on the long term plan, for the treatment and investigation of curable chronic cases. It is further suggested that physiotherapists should be urged to make fuller use of active movement on the part of patients, restricting passive procedures to the period of muscle-joint recovery and encouraging the patient in methods of self-development. The need for many more skilled physiotherapists is stressed and a plea is made for the inauguration of social surveys in relation to rheumatism. Additional measures of a community kind are the establishment of rehabilitation centres, the abatement of damp in houses, the provision of baths and means of drying clothes at mines and factories, and further research into the aetiology of the disease.

Special administrative arrangements are required for the control of juvenile rheumatism, which, in its acute form, is responsible for many deaths at pre-school ages. Among services designed to combat the rheumatic infection and its sequelae in children are residential special schools, hospital schools, cardiac supervisory clinics and long-term holiday homes. A close liaison is required between the rheumatic child and his medical practitioner, and with his school teacher, in order that the prolonged medical supervision and after care, so necessary in the prevention of disability, may be constantly maintained. The dissemination among parents, educationists and youth leaders of knowledge regarding rheumatism and its risks has also its part in the campaign. Much valuable propaganda work in this connection is now undertaken by the Empire Rheumatism Council. It has more than once been suggested that acute rheumatism should be made notifiable, so that timeous steps might be taken to prevent permanent disability.

Rickets

This nutritional disorder, which affects principally the first two or three years of life, is the expression of faulty metabolism in respect of calcium and diminished blood phosphorus. It reacts injuriously on the body as a whole but is most apparent in the dwarfism and deformity which result from the delayed calcification of bone during the age of growth.

Among the indications of rickets in the child are restlessness, irritability and sweating of the head, together with the rachitic cry. The flaws in bone formation are revealed in the square bossed head (Fig 120), the visibly enlarged epiphyses including the rachitic rosary, and the pigeon breast. The muscles are flabby, the ligaments relaxed, the abdomen protuberant and the liver and spleen palpable. Bronchitis and bronchopneumonia are common. Laryngismus stridulus, carpopedal spasm and tetany occur, and also convulsions.

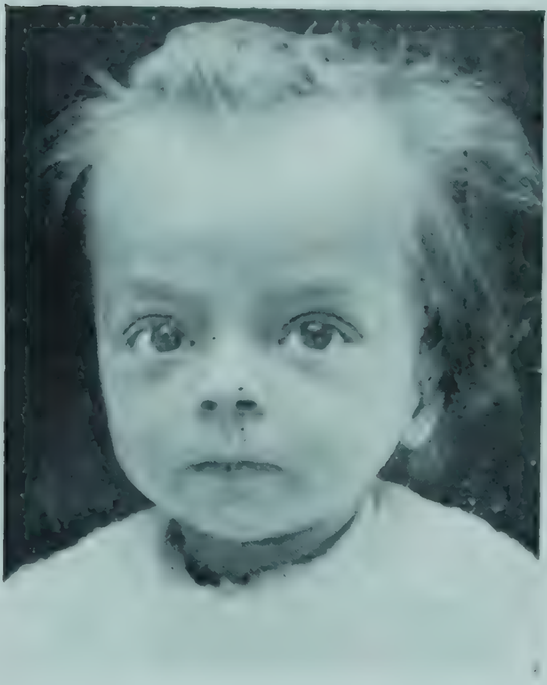

Fig. 120.—Bossing of Head in Rickets.

Rickets chiefly prevails in the large towns and industrial centres of temperate climates. It is not a disease of the tropics or subtropics. In India it is limited to the women and children secluded behind the purdah. It is unusual in native Africans, but negro children in North American cities are more subject than the children of white parents.

The disease belongs to the deficiency group, being the result of shortage of vitamin D. Its prevention or arrest consists in making up the shortage by exposing the child to sunlight or the open sky or the rays of the arc or mercury vapour lamp, or by administering cod liver oil or halibut liver oil, together with preparations containing calcium and phosphorus. When cow's milk is not a dependable source of vitamin D breast feeding is better than hand feeding. For infant treatment the dosage of halibut oil should begin with 5 minims twice daily, increasing gradually to 2 drachms per day by the ninth month of age. The use of iron to correct anaemia is helpful in most cases. Deformities benefit from massage, and in any event show a remarkable tendency to smooth out with the passage of time.

Sand-Fly Fever

This is a 3-day illness attended by headache, pyrexia, sharp articular and muscular pains and on occasion by a scarlatiniform rash. The blood shows a leucopenia. Convalescence may be prolonged by subsequent weakness and depression, but recovery is usual. The incubation period is 3-4 days. The disease is common in Southern Europe, the Levant, Egypt, Mesopotamia and India. The contagium vivum is a filter-passer which is present in the blood during the first 24 hours of illness. The vector is *Phlebotomus papatasii*,[1] and possibly other species of sandfly, which can pass the mesh of the ordinary mosquito curtain. The fly is an active biter. It may be held off by anointing the skin with an essential oil, such as citronella, and by avoiding its haunts, if known. Phlebotomus, once infected, remains infective for more than a week. The treatment of the illness is symptomatic.

Scarlet Fever

J. P. Ingrassias in 1550 distinguished the rash of the disease known in Naples as *rossania* or *rossalia* from that of measles. D. Sennert of Wittenberg in 1627 noted the occurrence in *rossania* of desquamation, *calor ferventissimus* and arthritic complications. Winsler of Brieg cited difficulty in swallowing as a symptom of the affection. T. Sydenham, who devised the name *febris scarlatina,* made no mention of sore throat. The distinction between scarlet fever and diphtheria was made by Bretonneau in 1824.

Headache, vomiting and sore throat, accompanied by pyrexia and circumoral pallor, usher in the attack of scarlet fever. The appearances in the throat may resemble those of follicular tonsillitis. The rash (Fig. 121), which appears on the second day of illness, shows first on the skin of the upper chest, from which it spreads downwards over the trunk and extremities, leaving the face free. It consists of minute points of a vivid red colour. The skin feels hot to the touch and blanches momentarily on pressure. Pigmentation is left in areas where the rash has been intense, as for example in the cubital fossae. Desquamation begins within a week, being visible on the chest. A week later the hands begin to peel and after a further week the feet. The process in slight cases may escape notice. Nephritis or albuminuria occurs in 5 per cent. of cases. The typical scarlatinal nephritis, when it occurs, usually develops late in the third week of illness or early in the fourth. Other complications are endocarditis, rhinitis, otitis media and polyarthritis.

Scarlet fever is widely distributed, but is most prevalent in temperate regions. It is uncommon in Australia. Adults, whether they have passed through an attack or not, are more immune than children. The period of maximum susceptibility is between the ages of 6 months and 3 years. The case mortality at the present time is about 1 per cent. and is maximal at the end of the first year.

The causative micro-organism of scarlet fever is a haemolytic streptococcus of Lancefield's Group *A* which remains localised about the fauces of the patient, and the disease is now regarded rather as a variant of the streptococcal syndrome than as a specific infection *per se*. An erythrogenic exotoxin which the streptococcus diffuses gives rise to the specific rash. The infection is spray-borne. The desquamated skin, unless contaminated by discharges, is not infectious. Nasal discharge and otorrhoea render convalescents infective for long periods, and from time to time lead to return cases at home after a patient has been dismissed from hospital. The chronic ear discharges are apt to contain diphtheroid bacteria, usually non-virulent. True diphtheria occurs in 1 per cent. of cases. The infection is readily conveyed by milk and ice cream.

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[1] Page 551.

Schultz Charlton Test. This test may be applied in doubtful cases. It consists in injecting intradermally at the site where the rash is brightest 0·2 ml. of a 1 in 10 dilution of anti-scarlatinal streptococcus horse serum. If the case is scarlet fever, blanching appears in 4 to 24 hours over an area of skin 1 inch in diameter, and may last till the exanthem fades. The test fails if applied to a rash which is not at its height, or if the patient's streptococcus differs in strain from the streptococcus used to produce the antiserum.

Treatment. Scarlatinal antitoxin may be used in the treatment of severe cases of scarlet fever. If given, it should, like diphtheria antitoxin, be given early. Either 10 ml. of the antitoxic serum or 3 ml. of the globulin concentrate should be administered by the intramuscular route. Larger amounts are required for toxic cases, for whom the intravenous route is advised. The injections may be combined with sulphathiazole or sulphadiazine, especially when septic complications threaten. Nephritis should not be regarded as a contraindication when sepis is also present. Otitis media is best treated by sulphadimethylpyrimidine. Severe cases of scarlet fever, and also cases about sources of milk supply, should be treated in an isolation hospital.

Dick Test. This test is employed to determine susceptibility to scarlet fever. 0·2 ml. of a 1 in 1000 dilution of streptococcus toxin standardised by the skin test method is introduced intradermally into the flexor aspect of the left forearm, and as a control the same amount of toxin inactivated by heating at 100° C. for 1 hour is similarly injected into the skin of the right forearm. The toxin reaction is shown by an area of redness which reaches its maximum in 24 hours and has practically vanished by the third day, leaving in some cases a slight brownish pigmentation. A protein reaction due to supersensitiveness of the person to protein contained in the material injected, which also develops on occasion, may be more persistent than the toxin reaction. Taking L = left arm, R = right arm, O = no reaction, T = toxin reaction, P = protein reaction, I = insusceptible and S = susceptible, the subjoined form summarises the appearances presented and shows the conclusion to be drawn :

L	O	T	P	TP
R	O	O	P	P
	I	*S*	*I*	*S*

The Dick test of susceptibility to scarlet fever does not possess the reliability of the Schick test in diphtheria.

Active Immunisation against scarlet fever is effected by means of scarlatinal streptococcus toxin of such a dilution that 1 ml. is equivalent to 500 skin test doses. The total amount given varies from 30,000 to 100,000 S.T.D. Injections are given at weekly intervals. Immunity is usually established in 2 weeks after the final injection and is believed to last for some years. The method has been employed (1) for the protection of nurses in scarlet fever wards, (2) for the protection of children in households to which a member of the family is expected to return from hospital on recovering from an attack of scarlet fever, and

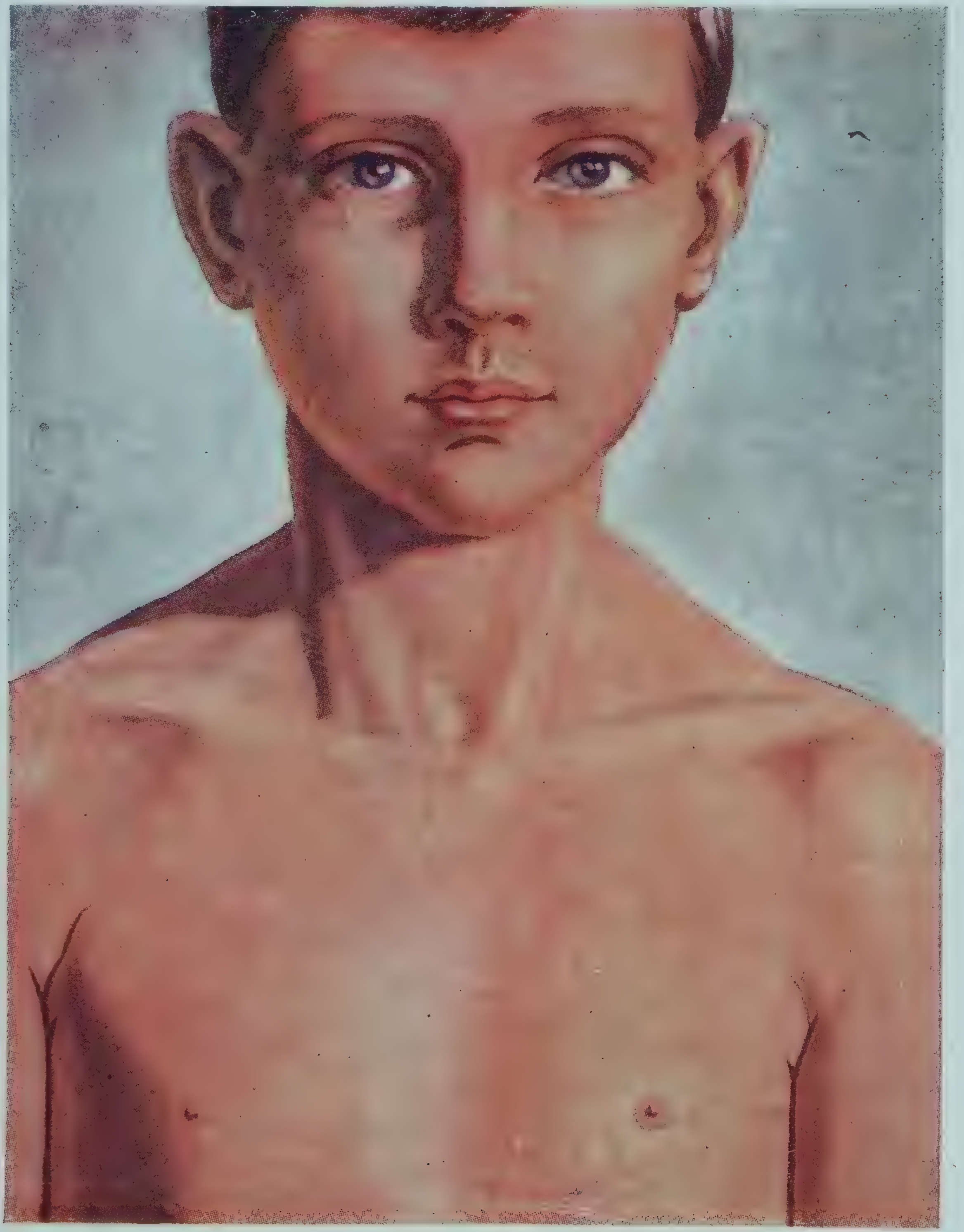


Fig. 121.—Scarlet Fever.

The rash on the third day of the fever. There is a suggestion of the circum-oral pallor. The clear bright eyes should be noted in contrast to the catarrhal state in measles.

(3) tentatively on a community basis for the protection of pre-school and school children.

Passive Immunisation with scarlatinal antitoxin may be used for the protection of contacts in institutions or cross-infected hospital wards. Ten ml. of the antitoxin or 1 ml. of the globulin concentrate is required to confer the immunity, which is very transient. On account of the present-day mildness of scarlet fever its use for contacts among the general population is best limited to conditions of special risk.

Certain strains of *Streptococcus haemolyticus* which do not yield erythrogenic toxin are apparently responsible for outbreaks of septic sore throat, especially in adults. The illness is characterised by the sudden onset of faucial pain, fever and malaise. The nasopharyngeal region is injected and, in severe cases, may be covered with exudate. The condition readily responds to sulphonamide therapy.

General measures for the control of scarlet fever and septic sore throat include the isolation of the sick, the exclusion of streptococcal carriers from dairy farms and milk shops, the pasteurisation of milk and ice cream and the suppression of dust. There is evidence that the administration of small doses, say, 0·5 gram, twice daily, of sulphadiazine may terminate an outbreak of scarlet fever in a closed community such as a boarding school.

It is not yet clear whether the 'fourth disease' described by C. Dukes and characterised by tonsillitis, macular rash and desquamation is a variant of scarlet fever or a type of rubella.

Scurvy

This disease results from shortage in the diet of vitamin C. It was formerly an affection of sailors in sailing ships. Nowadays, with quicker passages under steam, food supplies can be renewed at shorter intervals and the conditions which foster it seldom arise at sea. On land however it still appears from time to time among persons consuming an unbalanced diet. It has long been recognised as a complication of war.

Among the signs of scurvy are swelling of the gums, loosening of the teeth, ecchymoses and haemorrhages in many situations. Brawny swellings develop in the muscles. Headache and delirium occur and night blindness is a characteristic feature. In young persons there may be separation of the epiphyses and in advanced cases bone necrosis and anasarca.

Complete protection is afforded by a balanced diet including fresh fruit and vegetables. The latter must be cooked without the addition of soda, which would destroy the virtue of vitamin C. Orange juice, though boiled, and tomatoes, though processed in canning, retain their antiscorbutic properties.

Barlow's Disease, or Infantile Scurvy, occurs in young children, usually between the ages of 6 and 18 months. It is rare in breast fed infants and often follows upon the use of sterilised or preserved foods for infants. A typical case shows pallor and may exhibit gingivitis round an erupting tooth. The arms or legs may be tensely swollen. The child cries constantly and screams, when handled, owing to the acute tenderness of the affected bones. For the same reason a limb may be kept motionless, simulating paralysis. Haematuria, subcutaneous haemorrhages, separation of epiphyses and fractures of long bones may all occur. Treatment should begin with 1 to 3 drachms of orange juice daily, increasing to 2 ounces within a week. Tablets containing ascorbic acid in 50 milligram doses are now available for treatment. Each tablet is equivalent to rather more than 2 ounces of orange juice. Splints may be applied to the limbs. The response to treatment is usually rapid. Prophylaxis in early infancy should begin with full diet and ½ drachm of orange juice twice daily, increasing to 1 ounce daily by the fourth month.

Smallpox

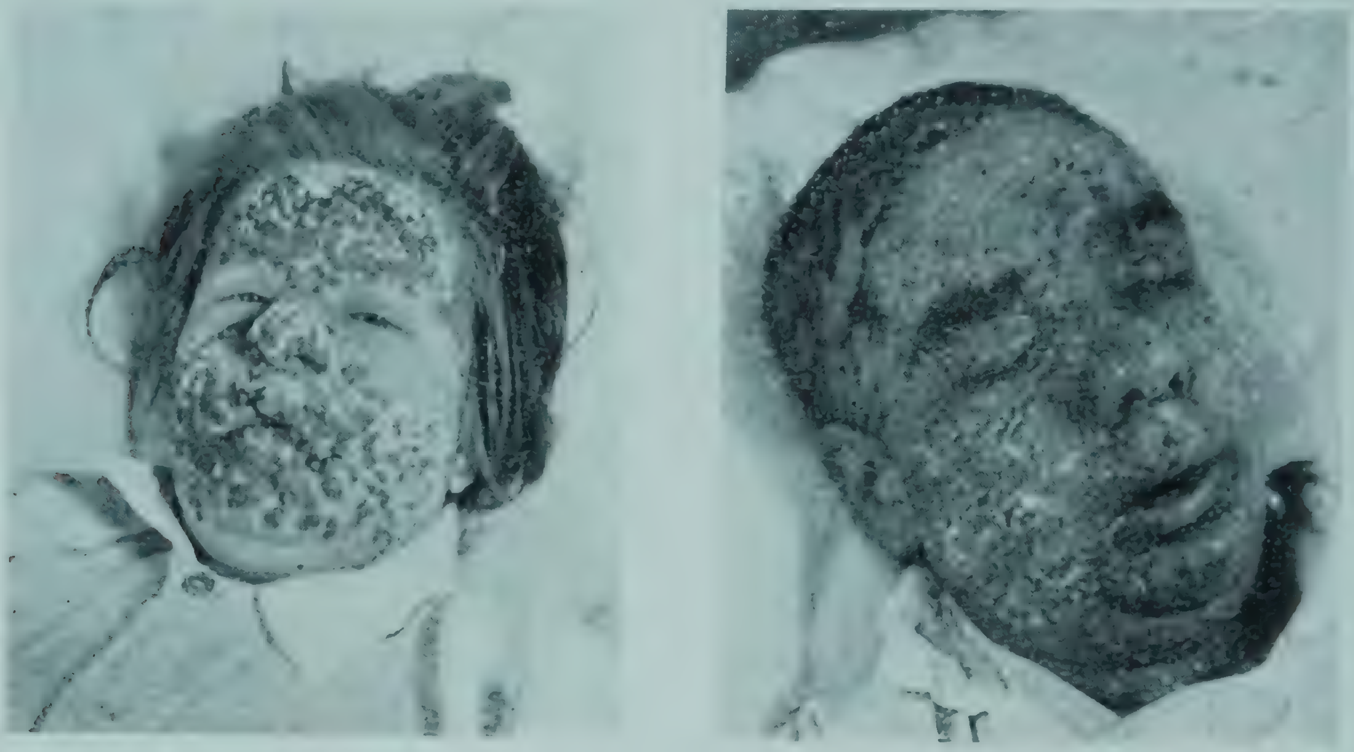
India, the Sudan and North Africa are the endemic centres of Variola or Smallpox. During the seventeenth century there were numerous outbreaks involving Britain and other countries, and a high incidence again during the eighteenth century. In 1744-63, of 11,613 deaths in Edinburgh, 1,185 were due to smallpox, and in the year 1775 among 15,000 people in Cheshire only 1,060 had not suffered from the disease. A check was imposed as from 1796 by the introduction of vaccination. In the Scottish epidemic of 1920-21, 813 cases were notified, with 176 deaths. In the outbreak of 1942 there were, between the months of May and December, 103 cases, with 25 deaths.

In most cases the attack of smallpox has an abrupt onset with severe headache and pain in the back, together with rise of temperature. On the third day, with the appearance of the exanthem, the temperature falls, but rises later to a second peak about the ninth day. During this period of remission the patient may feel sufficiently well to go out, and so may infect other persons. The eruption, which presents the four successive stages of papule, vesicle, pustule and crust, is more abundant on the face and extremities than on the trunk, and sweeps over the body in ordered sequence from above downwards. The papules are complete in 2 to 3 days and are succeeded 24 hours later by the multilocular vesicles, which may show umbilication. After 2 more days the vesicle contents become pustular. The pustules remain for 4 days and then desiccate over a period of 9 days, forming the crusts which finally separate a week or so later. The rash is described as discrete or confluent according to the number of the pocks. The papular stage may be preceded by an early roseola resembling measles, scarlet fever or urticaria or by a petechial rash in the axillae or groins. Early purpura may result in death before the papules appear. Late purpura during the stage of pustulation is usually fatal. Smallpox in general is a formidable disease, showing a mortality for confluent cases of 50 per cent. and producing permanent disfigurement in many who recover. Mild attacks, known as varioloid, may occur in vaccinated persons whose immunity is weakening with the lapse of time.

Variola Minor is a form of smallpox well known in the United States and prevalent for a number of years in England also. It is much less severe than smallpox proper, the mildness of the constitutional symptoms being in striking contrast to the profusion of the skin eruption.

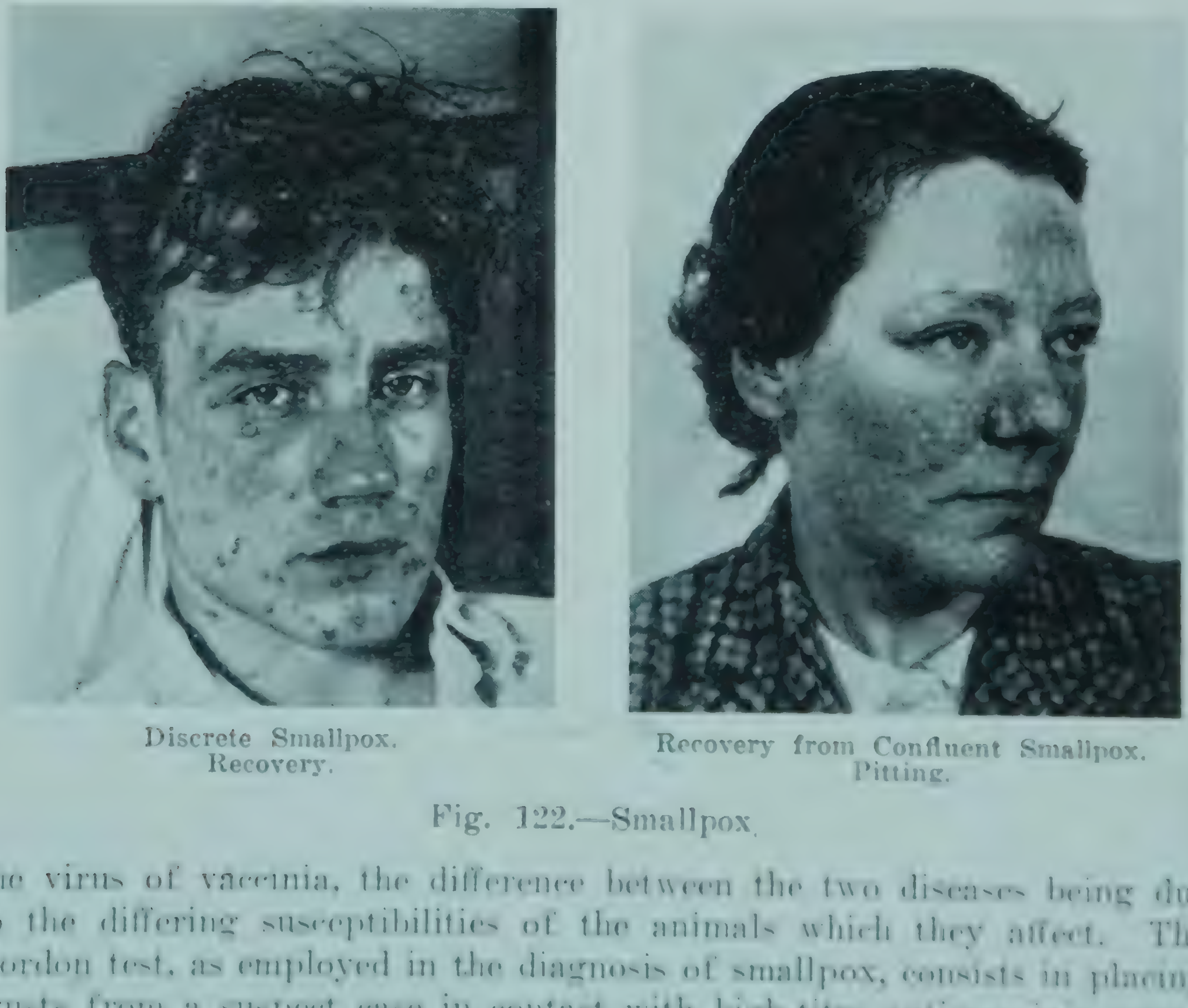
The disease is the same as the 'Alastrim' of South America and the 'Amaas' or 'Kaffir Pox' of the Cape Province. Opinion is divided as to whether it is capable of assuming major virulence.

The virus of smallpox is a filter-passer, serologically identical with the virus of vaccinia, the difference between the two diseases being due to the differing susceptibilities of the animals which they affect. The Gordon test, as employed in the diagnosis of smallpox, consists in placing crusts from a suspect case in contact with high-titre anti-vaccinia serum in a series of agglutination tubes. The positive reaction is denoted by



Confluent Smallpox.
Recovery.

Confluent Smallpox.
Fatal Case.



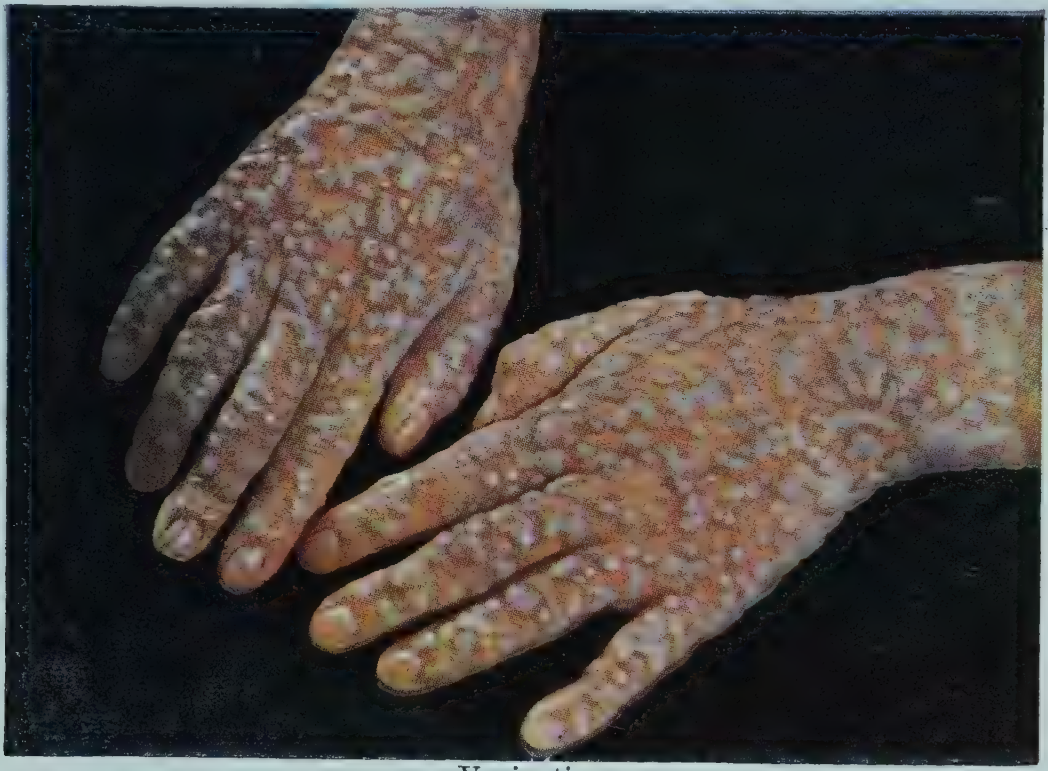
Discrete Smallpox.
Recovery.

Recovery from Confluent Smallpox.
Pitting.

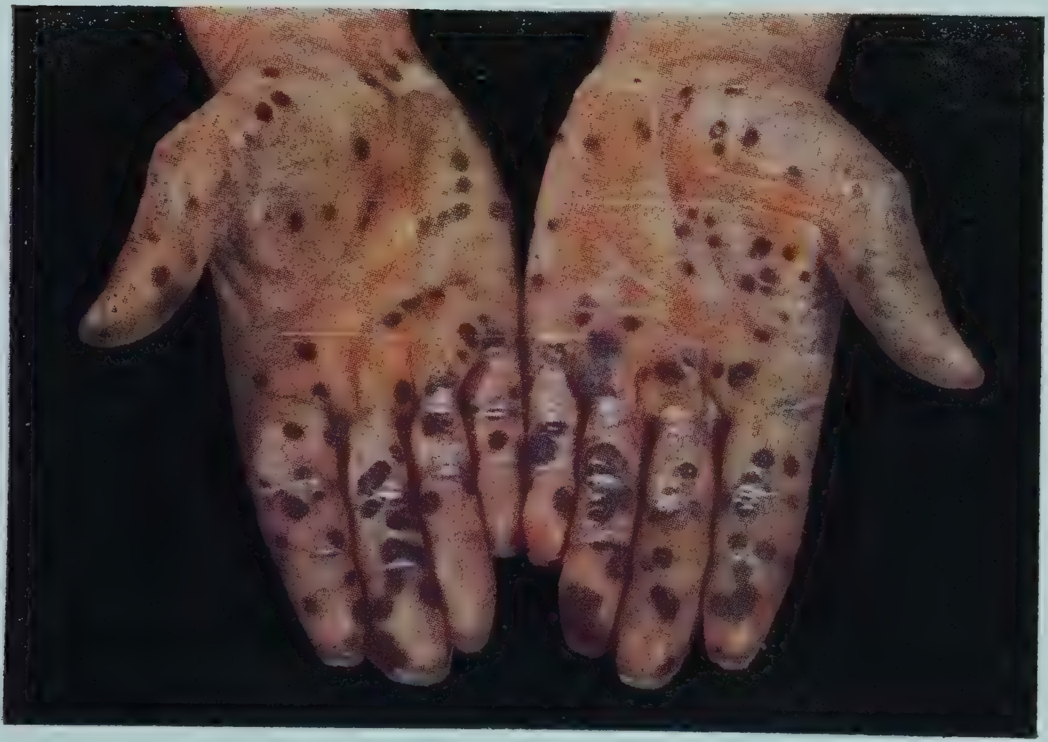
Fig. 122.—Smallpox.

the occurrence of flocculation in the tubes. Experience has shown that the test possesses, especially in the early stages of a smallpox epidemic, definite practical utility.

The infection in the main is spray-borne. The community prophylactic is adequate vaccination in infancy followed by adequate revaccination at the age of, say, 14 years. Patients suffering from smallpox should be removed to hospital, all necessary disinfection carried out, and all contacts diligently sought for. Some contacts may be found to have the disease: they will promptly be conveyed to hospital. Others, with their consent, should be vaccinated or revaccinated, the medical officer of health being empowered by regulation to perform the operation without charge. Whether vaccinated or revaccinated or not they should be kept



Vesication.



Crusting.

Fig. 123.—Hands in Smallpox.

under surveillance for 18 days. The vaccination of susceptible contacts within 3 days after exposure to infection will usually avert or mitigate the attack, and up to 6 days may modify it. When smallpox threatens to become epidemic, free vaccination should be offered to all comers, and chicken pox, for which smallpox is sometimes mistaken, should be made notifiable. The treatment of smallpox is chiefly symptomatic and depends much upon skilled and experienced nursing. Sulphonamides, especially sulphathiazole, and penicillin are of value in mitigating the secondary sepsis, and the application of 5 per cent. potassium permanganate lotion has a deodorant and soothing effect.

Vaccination is the procedure for establishing active immunity to smallpox by inoculating the person with vaccine lymph, which contains the vaccinia virus. The lymph used should be fresh. It is important that no non-volatile antiseptic be used to sterilise the skin lest its presence destroy the virus. Liquid soap followed by spirit is best. The order of events in a typical vaccination is as follows. After a latent period of 3 to 4 days there is reddening and itching at the site of inoculation, where a small superficial papule appears. The papule becomes vesicular by the fifth day and the vesicle, which is tense and multilocular, reaches its maturity by the seventh day. Pustulation accompanied by axillary adenitis then sets in. The pustule begins to dry on the eleventh day, and the crust which results generally separates about a fortnight later. The efficacy of vaccination followed by revaccination as a means of communal protection is exhibited in the following summary of the experience of Prussia during seventy years:—

Prussia, 1831-1900—Smallpox deaths per 100,000.

Year.	Civil.	Military.	
1831	11·9	75·0	
			1834. Vaccination and Revaccination of Army Recruits begun.
1841	14·5	2·4	
1851	13·0	2·3	
1861	30·2	...	
1871	243·2	30·5	
			1874. Vaccination and Revaccination of Civil Population begun.
1881	3·6	0·0	
1891	0·1	0·0	
1900	0·1	0·0	

The Vaccination Acts of 1867 and 1898 require parents or guardians to have children vaccinated by a public vaccinator or medical practitioner within 6 months of birth. If the parent or guardian so requires, the public vaccinator must visit the child in order to vaccinate. Four months after birth, if the child is unvaccinated, the public vaccinator must visit and offer vaccination with calf lymph or other Government lymph. Six months after birth, if the child is still unvaccinated, and notice duly given has not been complied with, the vaccination officer must prosecute. No parent or guardian is liable to penalty if within 4 months from the birth of the child he makes a statutory declaration before a Commissioner for Oaths, Justice of the Peace or other authorised officer that he conscientiously believes that vaccination would be prejudicial to the health of the child and within 7 days thereafter transmits the declaration to the vaccination officer.

In Scotland also vaccination is compulsory within 6 months of the birth of the child. It is to be done by a medical practitioner. There are no public vaccinators in Scotland, but vaccinators are appointed to vaccinate poor children and the children of defaulters. The 'conscience clause' applies in Scotland as in England.

The method of public vaccination in England and Wales is thus prescribed in an Order made by the Minister of Health:

> In all ordinary cases of vaccination or revaccination the public vaccinator should vaccinate in one insertion preferably by a single linear incision or scratch not more than ¼ inch long merely through the epidermis. This incision should be made in the long axis of the limb. The lymph may be applied to the cleansed skin and the incision made through it, or the lymph may be applied to the incision immediately after the latter has been made. The lymph may be gently rubbed into the scratch with the side of the needle or lancet. In cases in which the public vaccinator or the vaccinee (or the parent or other person having custody of a child vaccinee) desires to obtain additional protection at one operation (*i.e.*, where the maximum protection against smallpox is desired, or where the circumstances make it especially desirable to avoid risk of failure), the public vaccinator may, if he considers it necessary, increase the number of such insertions. The number of insertions should not exceed four, and they should be placed so as to avoid coalescence of the resulting vesicles. The aim of the public vaccinator should be to produce successful vaccination with the minimum of injury to the tissues. In no circumstances should the vaccinated area be cross-scarified or cross-hatched. All vaccinations should be inspected not less than 6 days and not more than 14 days after the operation.

The above instructions are for public vaccinators only. They are not addressed to private practitioners and they do not concern Scotland.

Prior to the Order there had occurred in England a number of cases of Post-Vaccinal Encephalitis in children of school age vaccinated for the first time. The symptoms included fever, headache, vomiting, strabismus, varying degrees of clouding of consciousness, convulsions and delirium. The case mortality was 50 per cent. The post mortem appearances were those of a diffuse encephalomyelitis. Further cases which occurred during the vaccination campaigns inaugurated to combat the Scottish outbreaks of smallpox in 1942 were for the most part adolescents who had not previously been vaccinated. With a view to the prevention of this serious complication a Committee recommended vaccination by one linear incision and also that primary vaccination should be performed during infancy, an age at which post-vaccinal encephalitis had been uncommon.

Lymph for the use of public vaccinators in England is prepared at the Government Lymph Establishment of the Ministry of Health from quarantined bull calves or heifers 4 to 6 months old. The calf is inoculated on the abdomen by scarification with lymph from a previous calf vaccinifer, either direct or after reactivation by *passage* through a rabbit. The vesicles which form are scraped off, and the pulp is ground in glycerine containing clove oil. It is then filled into receptacles which are sealed and placed in cold storage for about 2 years. When the bacterial content of the lymph has been sufficiently reduced a trial is made to test its potency. It is finally issued either in sealed capillary tubes each containing enough lymph for one vaccination, or in ampoules containing up to 100 doses. The calf is killed 2 days after scraping.

If it is proved at post mortem examination to be diseased the batch of lymph taken from it is discarded. Attempts to cultivate the virus on the chorio-allantoic membrane of chick embryos have now proved successful. It is possible that such virus will through time replace calf lymph, than which it appears to be more effective.

Tetanus

Clostridium tetani is a slightly motile spore-forming anaerobe, normally present in the spore stage in manured soil and inhabiting also the intestine of herbivorous and other animals. Introduced into wounds, especially when there is marked tissue destruction, it proliferates locally, liberating a powerful exotoxin which makes its way to the spinal cord and sets up the tonic spasms of the disease. The incubation period ranges from 2 to 20 days. The longer it is, the better the prospect of the patient's recovery. Early indications of the attack are stiffening of the muscles of the neck or jaw. Trismus or lockjaw is a constant symptom, resulting from the forcible contraction of the temporals and masseters. Risus sardonicus and opisthotonus follow in typical cases. The specific remedy is tetanus antitoxin prepared by immunising horses with the toxin of the clostridium. The dosage required is high, up to 200,000 units, given intravenously, not by the intrathecal route. Procedures in aid of the antitoxin are the intrathecal administration of magnesium sulphate and irrigation of the wound with hydrogen peroxide. Sedatives are required for spasm, and it is essential that the patient's strength be kept at the highest possible level.

With the view of preventing tetanus, wounds should be rendered surgically clean by antiseptic treatment or excision as soon as possible after infliction. Tetanus may follow the surgical re-opening of an old wound and on this account a pre-operative prophylactic injection of, say, 1500 units of the antiserum should be given. In civil life it should be the rule to administer tetanus antitoxin forthwith in all cases of horse bite, gun-shot wounding and punctured wounds of gardeners. The antitoxin is much more effective in prophylaxis than as a remedial agent.

The prevalence of tetanus in war has varied considerably in different campaigns, having been conditioned in general more by the soil constituents of battle fields than by the surgical resources of armies. Ground heavily manured or rich in chalk or lime is favourable to the infection: virgin soils and those with a low calcium content tend to be the reverse. In the Italian hospitals in the war of 1859 tetanus occurred in 10 per thousand of the wounded. In the Crimean War among British troops the rate was 2 per thousand, and in the American Civil War the same. In the Franco-German War the average for the German army was 3·5 cases per thousand wounded, including 1·6 round Metz and 11·0 in the northern theatre. In the South African War and the Russo-Japanese War tetanus all but vanished. During the First World War the total British cases of tetanus in Mesopotamia, Gallipoli, Salonica and Italy were 7, 6, 4 and 3 respectively. Tetanus rates on the Western Front in August and September, 1914, with little or no antitoxin available, were 8·5 and 8·8 per 1000 wounded. Adequate issues were made by November and at the end of the year the rate had fallen to 1·5. An increase took place in the early months of 1916, reaching its peak of 3·8 in April, partly owing to tetanus in trench foot cases, partly associated with the formation and move of the Fourth Army to the chalky and richly manured Somme area. Minor rises later were the result of heavy fighting when the evacuation of the wounded was disorganised. With these exceptions the rate in the last 2 years stood month after month near or below 1 case of tetanus per 1000 of wounded, less gassed.

Active immunity to tetanus may be conferred by the injection of tetanus toxoid. The approved procedure is to give two subcutaneous doses each of 1 ml., with six weeks between, followed nine months later by a boosting dose of 1 ml. It is now current practice in the Services to undertake active immunisation against tetanus and typhoid and paratyphoid fevers together. Highly concentrated T.A.B. vaccine is incorporated in 1 ml. of tetanus toxoid to form the compound lettered T.A.B.T. Two injections each of 1 ml., with four weeks between, suffice to confer the combined immunity. In similar fashion double immunity against tetanus and diphtheria may be conferred by reinforcing tetanus toxoid with toxoid antitoxin floccules. Three 1 ml. doses are required, with three weeks between. The first and third injections are of T.A.F.T., and the second of T.A.F. alone.

Trachoma

This affection of the eye is a contagious follicular conjunctivitis with characteristic 'sago' granulations. As a rule it is preceded by some other abnormal eye condition. Following the acute stage of granulation, there is a chronic stage of cicatrisation as a result of which the lids may become deformed. When pannus occurs the sight may be ruined.

Trachoma occurs principally in Eastern Europe, Russia, the Orient and in the East and Middle West of the United States. It is endemic, though not prevalent, locally in Britain. It is notifiable in Glasgow. Aliens suffering from trachoma who seek to enter this country for more than 3 months' residence are refused leave to land.

The spread of trachoma is favoured by malnutrition, overcrowding and inadequate personal cleanliness. Towels which are used in common may take up the infective eye discharges and pass the contagion on. Irrigation with zinc sulphate solution is beneficial. Good results are now reported to follow the administration of sulphanilamide, both orally and as a saturated solution applied to the lesion. Deformity of the eyelids may require surgical treatment. The specific agent of the disease is a filter-passing virus.

Trench Fever

The trench fever of the First World War, known also as Meuse fever and Quintan fever, although not a fatal disease, caused much invalidity in our armies on the Western front. It was known to the enemy, who suffered also, as Volhynian fever. It has occurred also in Irak, and what appears to be a variant of the infection is endemic in Tunis at the present time. The illness is attended with fever, headache, pains in the legs and back associated with hyperaesthesia, moderate leucocytosis and slight splenic enlargement. The initial pyrexia lasts 5 days but is often followed by repeated relapses and subsequent neurasthenia. The causative agent is believed to be *Rickettsia quintana*. The vector is the body louse, by which the pathogen is excreted in the faeces. Treatment is symptomatic.

Trypanosomiasis

This grave infection in its several forms is occasioned by the parasitism in man of the haemoflagellate genus Trypanosoma. Meningo-encephalitis is the characteristic lesion. For each type of the disease the vector is a winged insect, and for each there is a mammalian reservoir host in addition to man. The three types are (1) Gambian Trypanosomiasis, (2) Rhodesian Trypanosomiasis and (3) Chagas's Disease. They will be dealt with in order.

Gambian Trypanosomiasis occurs widely in Africa from Senegal to Kenia Colony and southward to Angola. In Uganda the population of infected districts was brought down in six years from 300,000 to 100,000. An early sign is enlargement of the cervical glands, as was well known to the old-time slave traders. Other symptoms are irregular fever, skin eruptions and paraesthesiae. These manifestations may last up to 7 years before the closing phase sets in, with lethargy, shuffling gait and finally the somnolence, on account of which the disease has been called 'sleeping sickness.' After a phase of muscular rigidity and tremor, torpor deepens into coma, tissue wasting ensues, contractures develop and bed-sores form. At last the subject dies comatose, of asthenia or

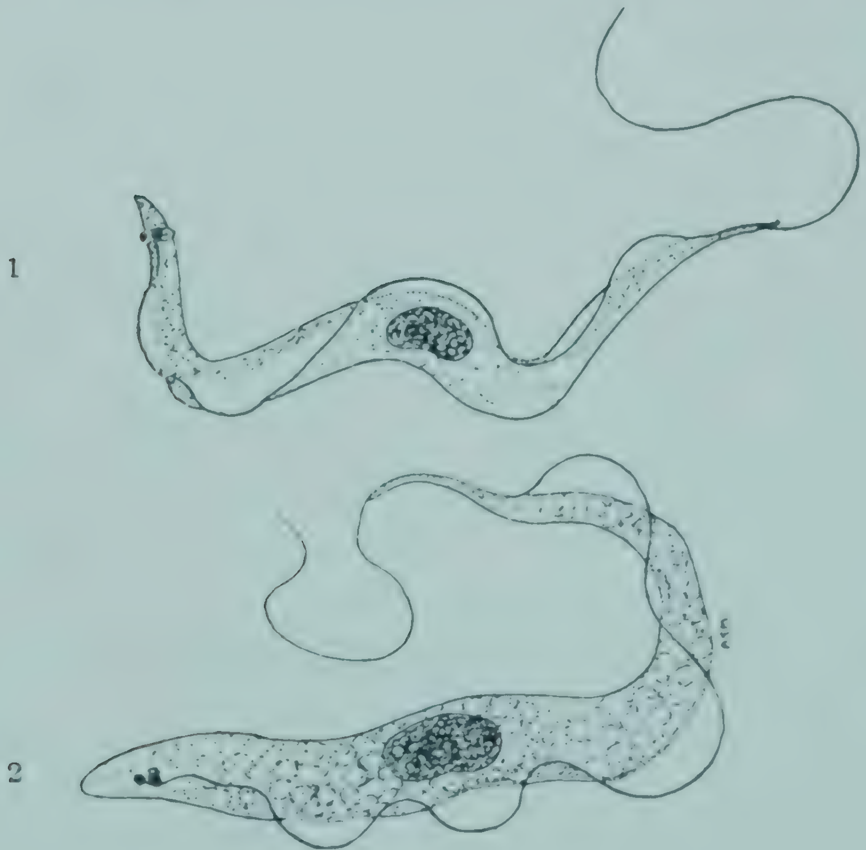


Fig. 124.—Trypanosomes.
1 T. cruzi. 2 T. gambiense. (x 1200).

an intercurrent infection. The specific trypanosome is *T. gambiense,* the insect vector is the tsetse fly *Glossina palpalis,* and among the reservoir hosts are species of antelope. The sitatunga is often found naturally infected. Domestic oxen, goats and sheep may also harbour the parasite.

Rhodesian Trypanosomiasis is more narrowly localised in Africa, mainly between north-eastern Rhodesia, Tanganyika Territory, Mozambique and part of Nyasaland. The Rhodesian sickness is more virulent than the Gambian, and the characteristic enlargement of the cervical glands may be absent. It may reach a fatal issue within a year. The specific trypanosome is *T. rhodesiense* and the tsetse vector is *Glossina morsitans,* which conveys also the horse sickness Nagana occasioned by *Trypanosoma brucei.*

Diagnosis in both types is established by demonstrating the trypanosomes either in wet preparations or in stained films of the fluid obtained by gland or sternal puncture. Alternatively, the patient's blood may be inoculated into guinea pigs, in the peripheral circulation of which the parasites may later be demonstrable by dark field technique or in stained films.

Among drugs beneficial in the early stages are Bayer 205, known also as suramin, moronyl 309 and antrypol, given by the intravenous route. For the later stages, tryparsamide is more effective. Promising results are claimed from guanidine compounds such as synthalin. Patients who suffer also from malaria or other parasitic infection may not tolerate trypanicidal drugs well, and on this account such incidental infections should first be eliminated.

The principal preventive measure is tsetse control.[1] The specific remedies may be employed also for personal prophylaxis.

The following advice to administrators applies to both the Gambian and the Rhodesian types of sleeping sickness: 'Steps should be taken to unmask infective persons, the old slave trade test, enlarged cervical glands, being used as a general guide. Cases may be rendered non-infective by mass treatment with atoxyl, tryparsamide or similar remedy which drives the parasite from the peripheral blood. The movements of suspects should as far as possible be controlled, or all the inhabitants of infected villages may be transferred to camps in fly-free country. The maintenance of order throughout all districts is of the first importance. In sickness areas the houses of Europeans, and also river and lake steamers, should be fly-proofed with non-corrosive screens. Puttees should be worn. Persons crossing fly belts should make the transit at night since most species of Glossina are day-time biters.'

Chagas's Disease is the South American trypanosomiasis, with its main location in Brazil and Venezuela. It is an affection of childhood, beginning in infancy with fever, anasarca and enlargement of the liver, spleen, thyroid and superficial lymphatic glands. The incubation period is 7 to 14 days. In fatal cases coma develops and death supervenes in a month from onset. The children who do not die enter upon a chronic state with cardiac and nervous derangement or myxoedema. Complete recovery is unusual. Arsenicals have little effect on the course of the disease. Diagnosis is confirmed by demonstrating the parasite in smears of the patient's blood. A complement fixation test also is available. The specific trypanosome is *T. cruzi*, the insect vector is the winged bug *Conorhinus megistus* and the reservoir host is the armadillo. As regards Conorhinus it is some advantage to sleep in a hammock, which baffles the crawling nymph and larva as they seek the sleeper's blood. To escape the bite of the night-flying adult bug a mosquito curtain is necessary. It is deemed useful also to demolish the mud-walled huts of the native population. The main preventive effort is directed against the armadillo.

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[1] Page 561.

Tuberculosis

Evidence of the ancient origin of this disease is furnished by the discovery of typical osseous lesions in Egyptian mummies of the period 2000 B.C. Hippocrates epitomised the wasting syndrome of the illness by his use of the term 'phthisis' to describe its course. The modern word tuberculosis most probably derives from the expression 'tubercle' employed by Sylvius in the 17th century to denote the lesion which he found in the lung of a fatal case.

Tuberculosis is acquired by man as a result of infection with the human or bovine type of the tubercle bacillus. Infection by the human type is principally conveyed in the sputum of open pulmonary tuberculosis, either directly spray-borne or dried so as to form dust, which may be inhaled or, on occasion, blown into milk. Infection by the bovine bacillus originates almost exclusively from cow's milk containing tubercle bacilli. The rôle of milk as a vehicle for the tubercle bacillus, and the methods of milk control are discussed elsewhere. Given effective meat inspection the risk from beef is negligible. Five per cent. of all the tuberculosis deaths in England are due to bovine bacilli : under the age of 15 the proportion is 25 per cent. Neither piscine nor avian strains produce disease in Man.

Tuberculosis is world wide in its incidence, though certain climates are more favourable than others to recovery from it. Thus the climate of the Alps, with its sunshine and cool air, is renowned for the cure of surgical tuberculosis (Figs. 126 and 127), and is also beneficial for early cases of phthisis in whom the disease is localised and the prospect of response good. The prevalence of tuberculosis differs widely in different countries. In pre-war New Zealand it was low, but in France high. It is in general low in rural districts, higher in urban communities, and specially high in congested areas. The disease may occur at any age and is, especially in its pulmonary forms, more frequent in males.

Among predisposing factors are poverty, and overcrowding in houses. Most of the cases derive from one- and two-roomed dwellings. Less stress is now laid upon hereditary diathesis as a predisposing cause. The relationship of occupation to tuberculosis has already been discussed. Recent evidence suggests that occupational hazards are not alone responsible, but that causal agencies exist which are not overcome by the promotion of factory hygiene and welfare. Certain systemic diseases including diabetes render their victims liable to phthisis and the infection is not uncommon amongst the intemperate and the insane.

The pathogen, *B. tuberculosis* (Fig 125), was discovered by R. Koch in 1884. It is resistant to chemicals and to heat but is readily killed by sunlight. Two types of the organism occur in man, the human and the bovine. They are readily distinguished by their cultural characters in glycerin media. The specific tissue reactions to the tubercle bacillus are of service in dealing with bovines, but have a less direct application to man. The intradermal tuberculin test is reliable for the cow. The von Pirquet scarification test has largely been abandoned for Man in favour of the Mantoux intradermal test, which employs heat concentrated Old Tuberculin in buffer-citrate dilutions of 1 in 10,000, 1 in 1,000 and 1 in 100 respectively. The dose in each case is 0·1 ml. When the higher dilutions markedly elicit the positive reaction, which is an erythema with swelling, the presence of an active tuberculous focus is suggested. Negative reactors are assumed not to have undergone primary infection. Precipitated Protein Derivative (Seibert) as employed in the United States is claimed to be a more stable preparation. The tuberculin patch

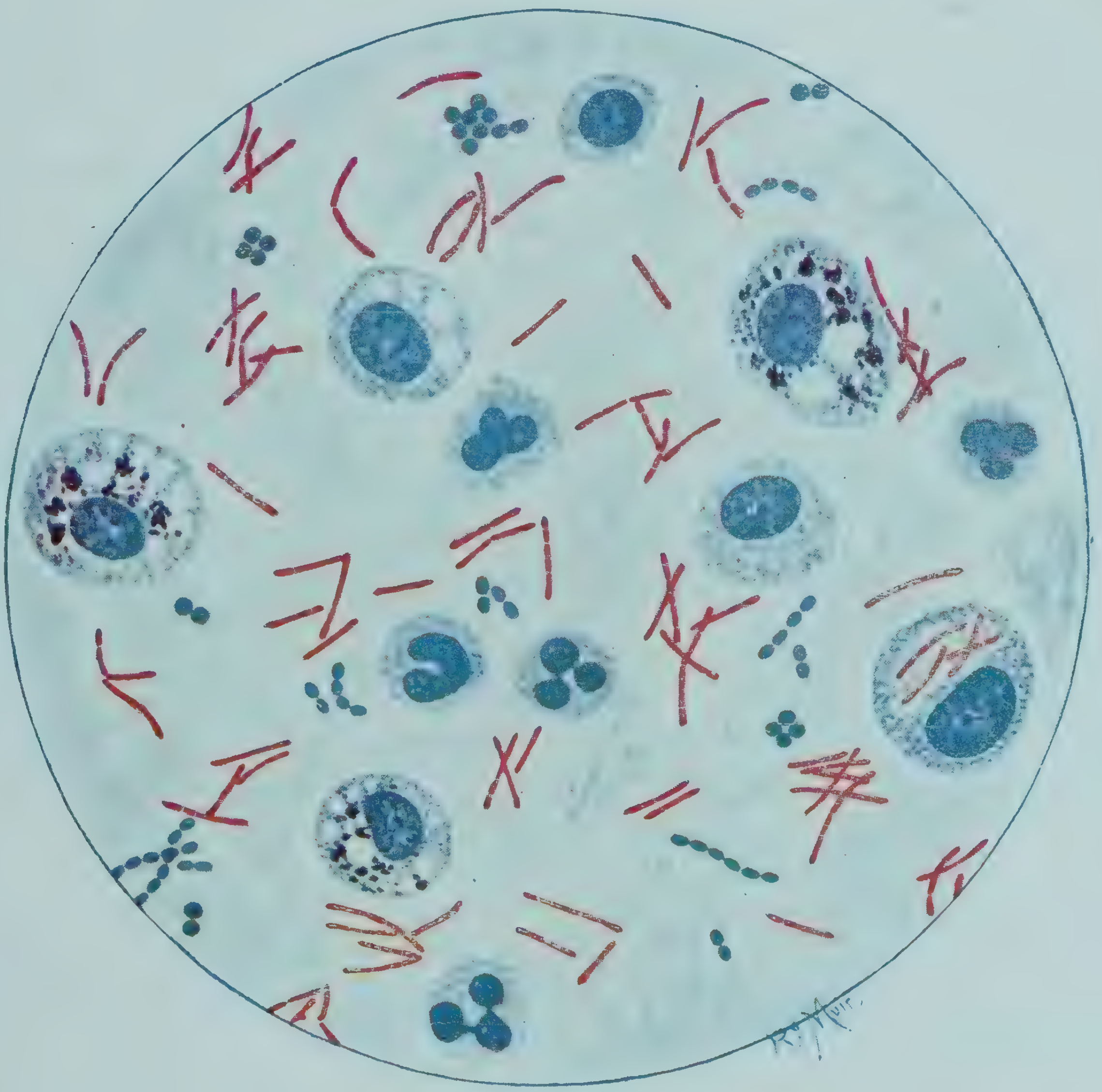


Fig. 125.

Tubercle Bacilli, in a specimen of Sputum, stained by the Ziehl-Neelsen method. (After Richard Muir.)

test is not considered by experts to be sufficiently reliable for general use. The Standing Advisory Committee on Tuberculosis have recommended that Mantoux-negative nurses in hospitals and sanatoria should be subjected to chest radiography on appointment, and at six monthly intervals during residence in hospital. Similar precautions are recommended for domestic staffs who are exposed to the risk of tuberculosis.

The B.C.G. or Bacille Calmette Guérin, which is an attenuated strain of the tubercle bacillus, has been successfully employed for the immunisation of calves. Its applications to the human subject are still under review. It is used by some authorities to convert Mantoux-negative subjects to the positive reaction state.

A notable and progressive decline in the death rate from tuberculosis has been apparent in England and Wales since 1871. Round that year it was 3·7 per thousand. Round 1921 it had fallen to 1·1 per thousand. In 1931 it was 0·8 and in 1941 0·69. This reduced mortality has been attributed to the elimination of susceptible strains, leaving a population more refractory to invasion by the bacillus, or alternatively it has been ascribed to the subinfective immunisation of communal life, which would produce the same result. These factors were doubtless operative during the early stages of the recession. More recently we may find a cause in the general rise in the standard of living, the healthier use of leisure, the improved status of the working classes enabling them to include more fat in their dietaries, or the organisation of specific measures for the control of the infection. The credit may be distributed among these good influences, since all such work together for the repression of disease. The decline in the death rate of the non-pulmonary form of the disease is due in part to an improvement in the quality of the milk supply and in part to the increasing care of child life. The abnormal conditions of war have, as was expected, been responsible for an increased incidence at the present time.

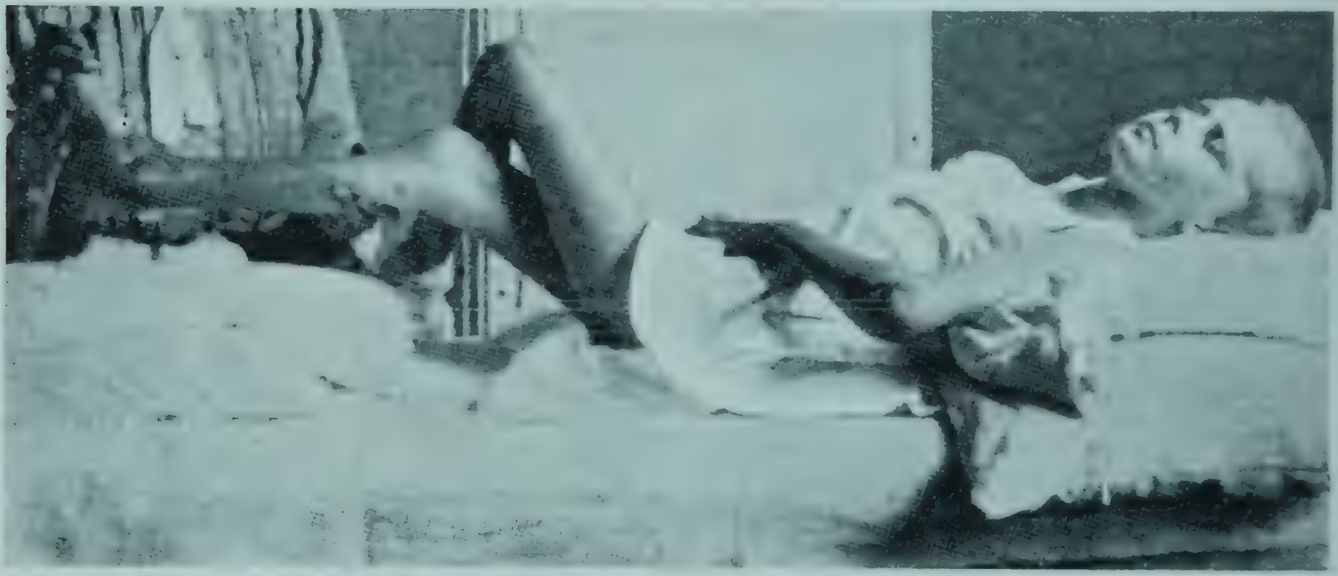


Fig. 126.—Surgical Tuberculosis before treatment.

Tuberculosis presents itself in a variety of forms according to the organ or tissue affected. The essential lesion is the tubercle, which forms round a series of giant cells. Later, caseation of the mass occurs, and the pus of a 'cold abscess' results. Fibrosis may lead to healing at this stage, or the lesion may proceed to cavity formation with, in some cases, extension to organs near or remote. (1) *Phthisis pulmonalis* may be acute or chronic. The bacillus with a few exceptions is of the human type. In the acute and less common form of the disease, the course is rapid and terminates fatally, usually within a few months. The lesion is frequently a bi-lateral bronchopneumonia and the symptoms are fever, cough and urgent dyspnoea. Death is from toxaemia. Chronic phthisis generally begins with loss of weight, anorexia, fever, night sweats, cough and expectoration. When sudden haemoptysis is the initial symptom, as in 10 per cent of the cases, loss of weight is more rapid and the characteristic physical signs appear in the lung. Pleural effusion in an adult is suggestive of tuberculosis. The presence of the bacillus in the sputum, demonstrated either by direct examination or by guinea pig inoculation, confirms the diagnosis. The examination of specially stained films in the presence of ultra-violet light is now claimed to yield a higher percentage of positive results. The illness may be prolonged, with or without remissions, but, under appropriate treatment, arrest of the disease is possible and even recovery. For the detection of deep-seated lesions x-ray photography is required, and is of value also in assessing the degree of mischief and for controlling the effects of treatment (Fig. 128). (2) *Tuberculous meningitis*, which is usually secondary and occurs mainly in children, is attended by headache, grinding of the teeth and somnolence increasing to coma. The cerebrospinal fluid shows an increased protein content and an excess of lymphocytes and, on being allowed to stand for some hours, forms a

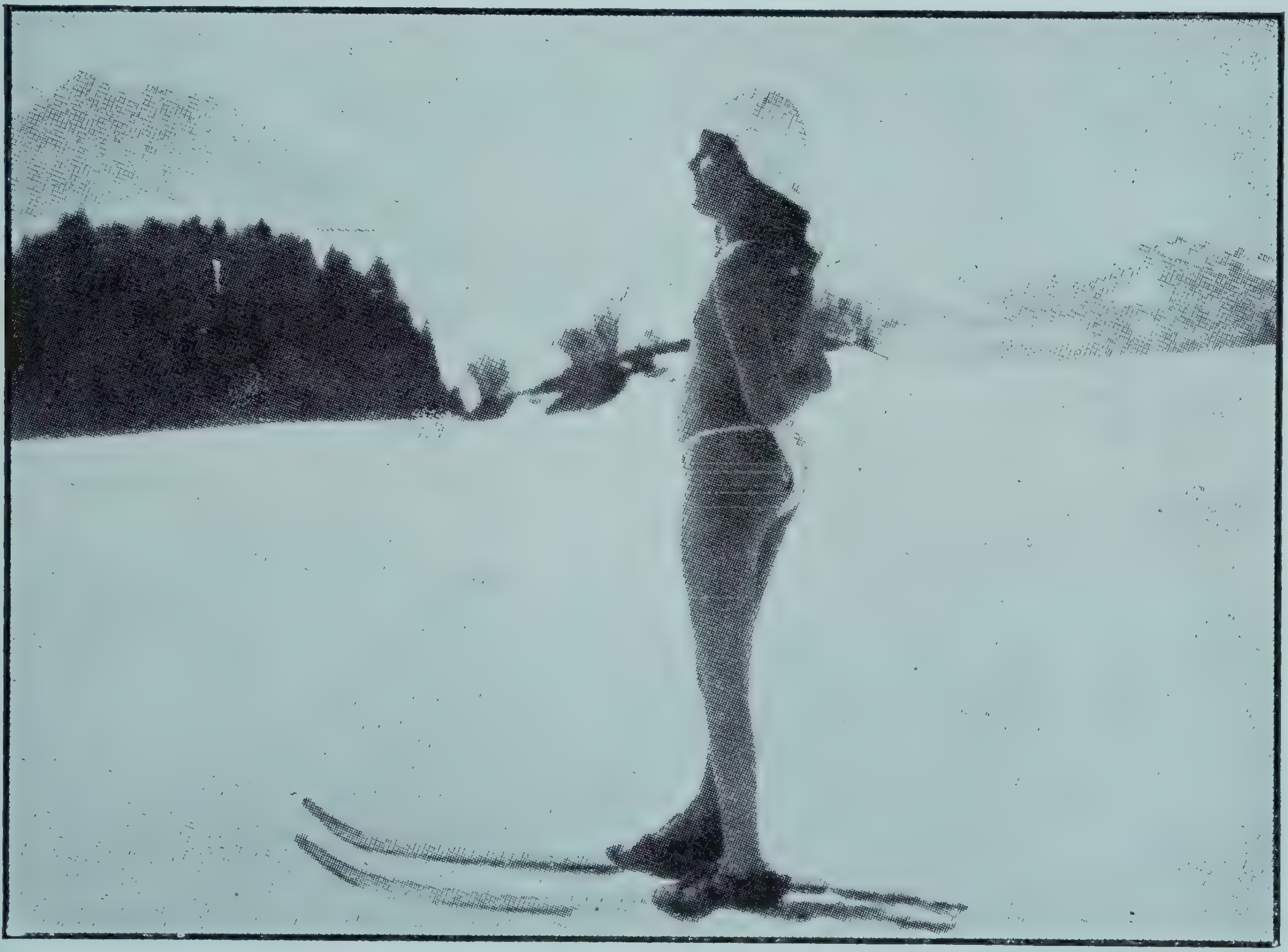
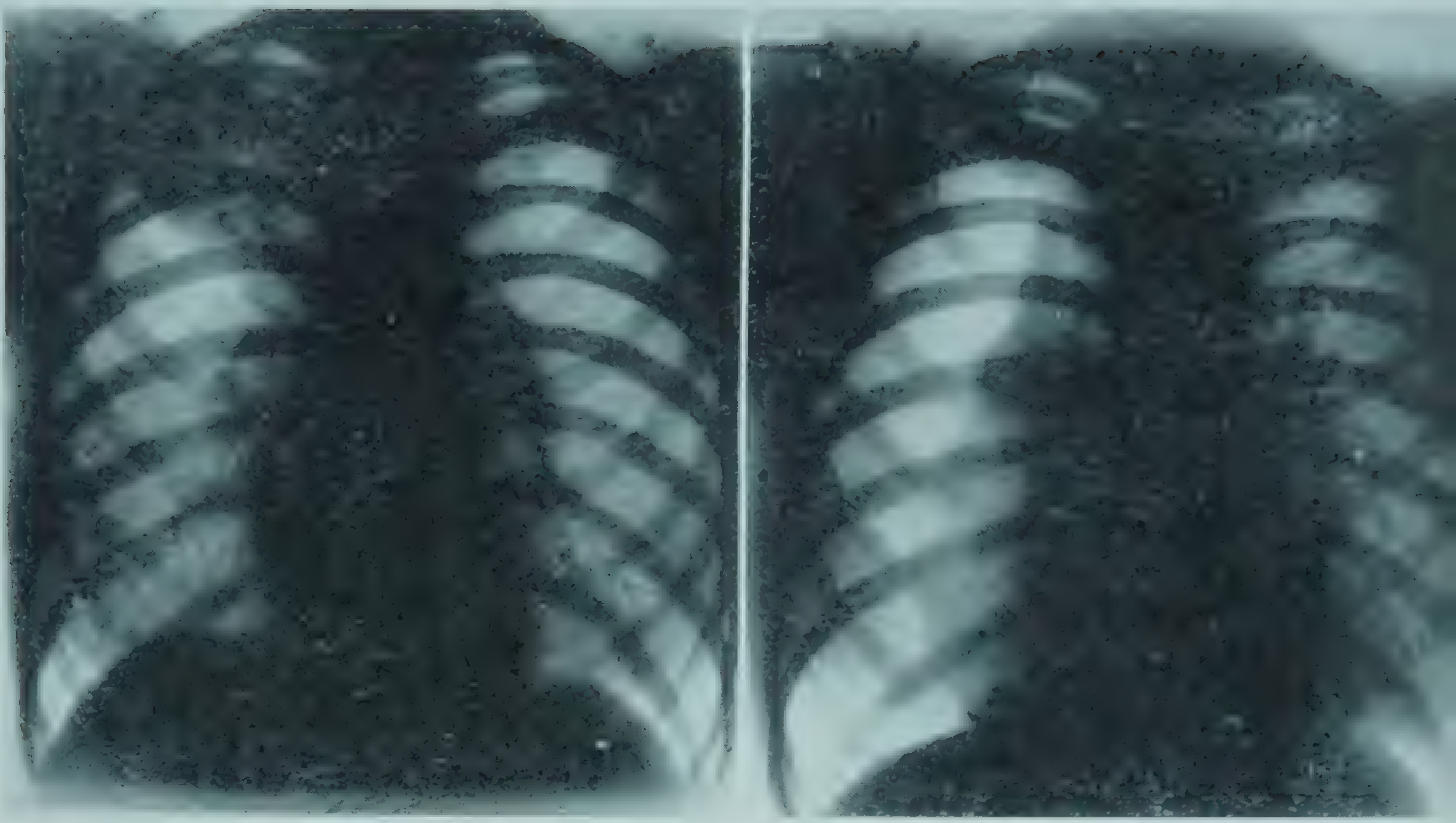


Fig. 127.—The same Patient after treatment by Alpine Helio-Therapy and Open Air.

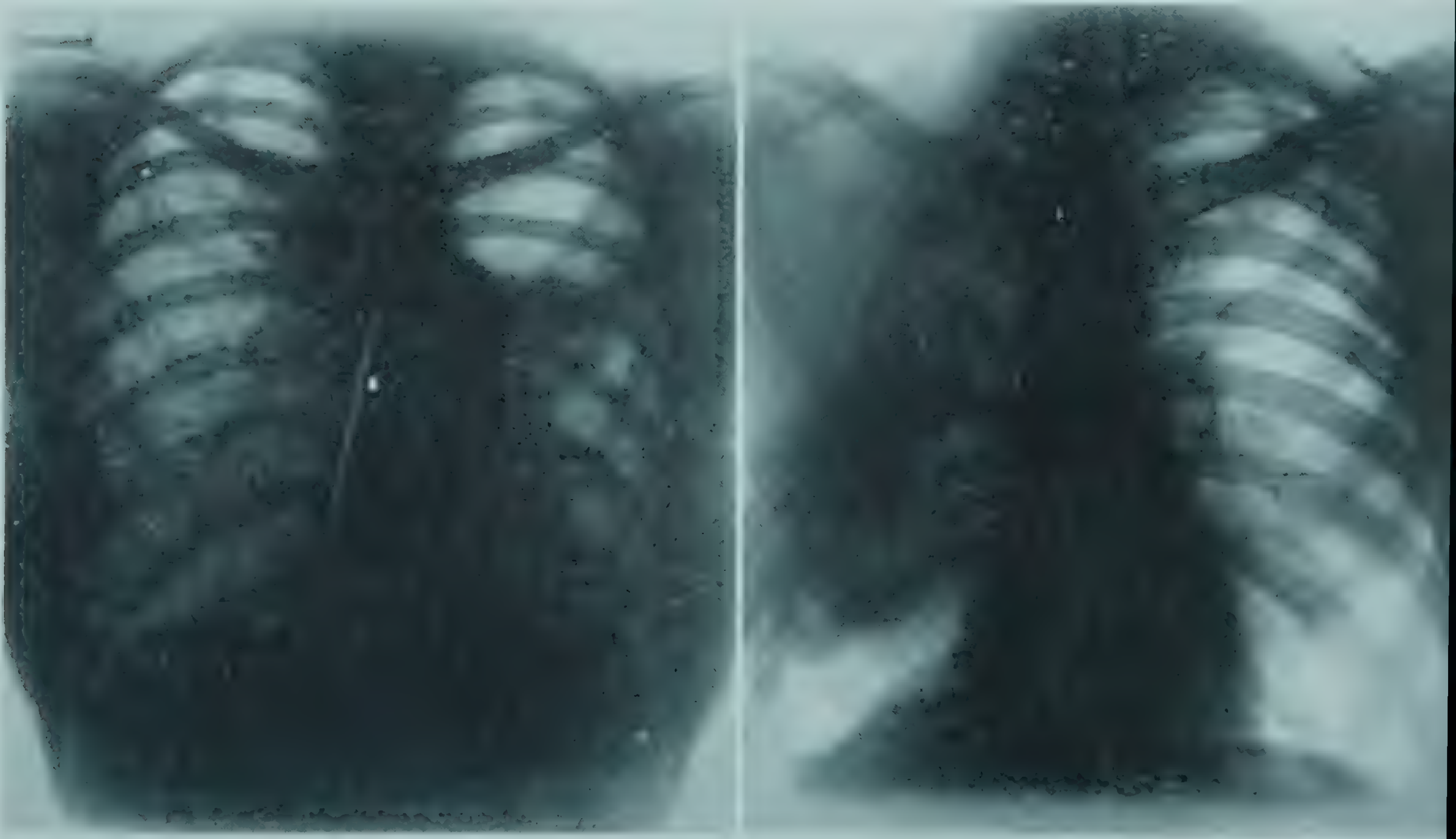


A

Early tuberculosis of right upper lobe.

B

Artificial pneumothorax of right side.



C

Large tuberculous cavity of left upper lobe.

D

Eight-rib thoracoplasty of right side.

Fig. 128.—X-ray Appearances in Phthisis.

characteristic coagulum in which the bacilli are often demonstrable by skilled technique. Death occurs in 4 to 10 weeks. (3) *Tuberculous peritonitis* as affecting children and young adults is predominantly due to the bovine strain and the symptoms include ascites, diarrhoea, night sweats and emaciation. The disease is usually secondary, the intestine being frequently involved. (4) *Surgical tuberculosis* includes tuberculosis of the lymphatic glands. As bone-joint tuberculosis and especially spinal caries it is often attended by crippling and deformity. (5) *Tuberculous laryngitis* is a sequela of phthisis pulmonalis and occurs chiefly in men. The symptoms include hoarseness, aphonia and pain which is aggravated by swallowing. (6) *Lupus* is tuberculosis of the skin, most commonly affecting the face. The primary lesion is an intradermal nodule from which the disease advances in serpiginous fashion, leaving erosion in its wake. The human and bovine strains are each responsible for half the cases.

The control of tuberculosis begins with the notification of the disease, with a view to which the practitioner has at his disposal the laboratory of the local authority for the examination of sputum and the expert advice of the tuberculosis officer on the condition of his patient.

Such advice will often be given at the tuberculosis clinic or ‘dispensary’ as it was called by its originator, Sir Robert Philip. The dispensary may be an integral part of a health or welfare centre, or it may be a separate building. It is presided over by the tuberculosis officer to whom cases of doubtful nature may be referred for diagnosis. Here the patient will be examined with all appropriate facilities, including radiography, and a decision reached as to the place and manner of his treatment. On this decision, due to be made by the medical officer of the clinic, the patient's future depends. The customary provision of clinics is one for every 200,000 of the population. The success of the clinic depends largely upon the tuberculosis officer, who should be a clinician of consultant rank and should have an appreciation of the social problems of tuberculosis.

As a result of diagnosis the patient is classified, on the Ministry of Health plan, as ‘T.b. minus’ and ‘T.b. plus.’ Cases classified as ‘T.b. plus are termed Group I when the physical signs are few or limited and the constitutional disturbance slight. Group III includes the advanced cases with untoward or grave prognosis. Cases not referred to Groups I or III make up Group II.

If the patient is treated at home, he is instructed there by the tuberculosis nurse in the hygiene of his ailment, which includes the use and care of the sputum flask, a separate bedroom, separate food utensils and other precautions. If insured, he is entitled to be attended by his insurance doctor, who may order dressings, food and medical comforts for him at the expense of the insurance fund.

If he is sent to a hospital or sanatorium he benefits by fresh air, good food, graduated exercises and ordered rest for both his lung and his body. If artificial pneumothorax is induced he may, during the year or so of its maintenance by refills of nitrogen or air, be discharged for domiciliary treatment, returning at prescribed intervals for his refills and remaining under x-ray control. Artificial pneumoperitoneum is also employed. Suitable cases are now successfully treated by thoracoplasty (Fig 129) which aims at permanent collapse of the diseased lung by the resection of ribs. *Mycobacterium tuberculosis* is resistant both to sulphonamides and to penicillin. The anti-biotic Streptomycin is now on trial as a therapeutic agent in the disease.

For lupus the Finsen light renders good service, and results are

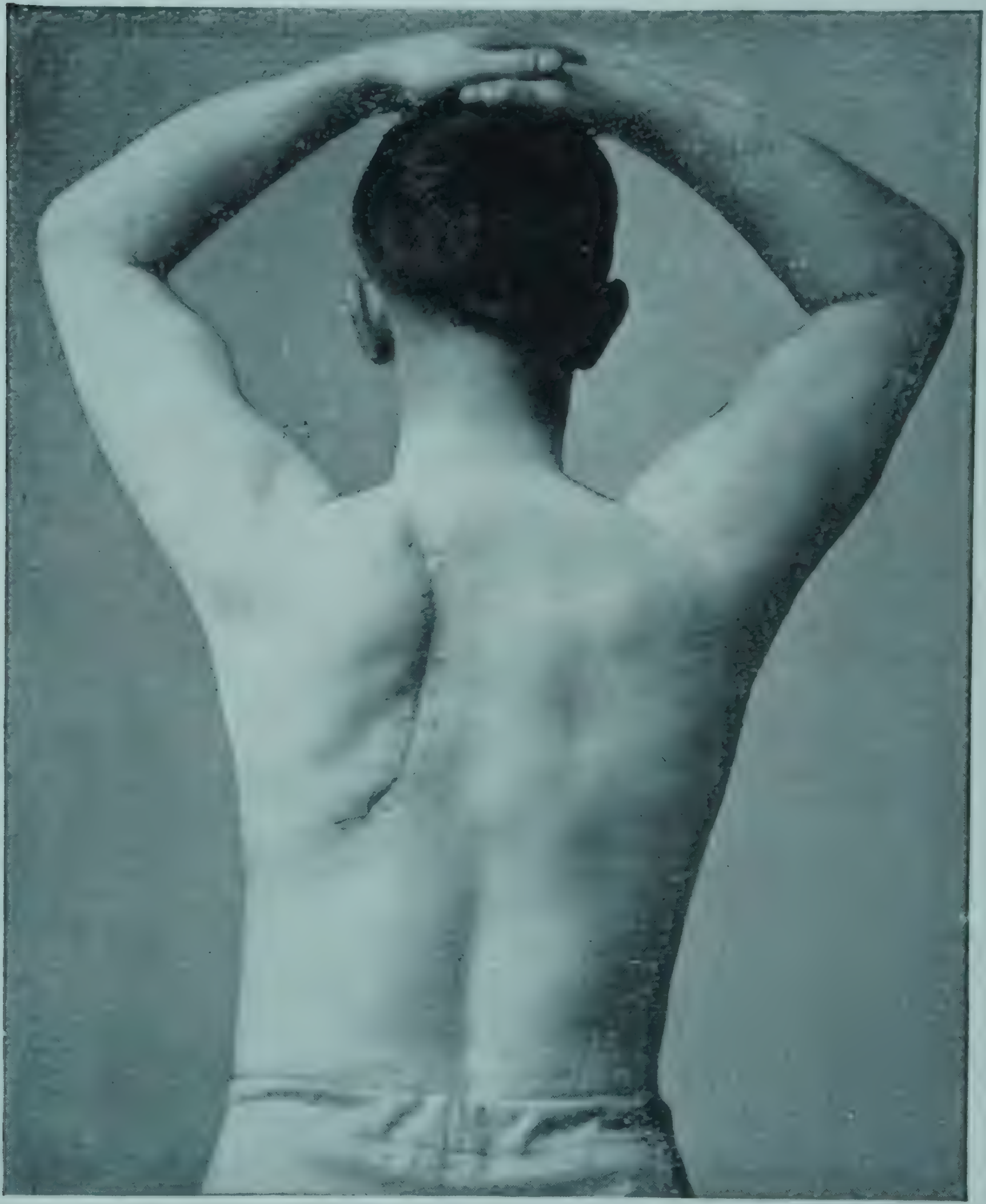


Fig. 129.—Thoracoplasty Scar.

claimed also for the intravenous injection of gold preparations, notably 'sanocrysin.' A careful watch should however be kept for reactions to gold. Such should be the signal for its discontinuance.

Early cases of tuberculosis receive sanatorium treatment, which may be given in an institution receiving all grades of the disease, but is best provided, wherever possible, in a separate sanatorium in order that recurring deaths may not depress the hopeful cases. Vocational training and occupational therapy should be provided for all who are fit to

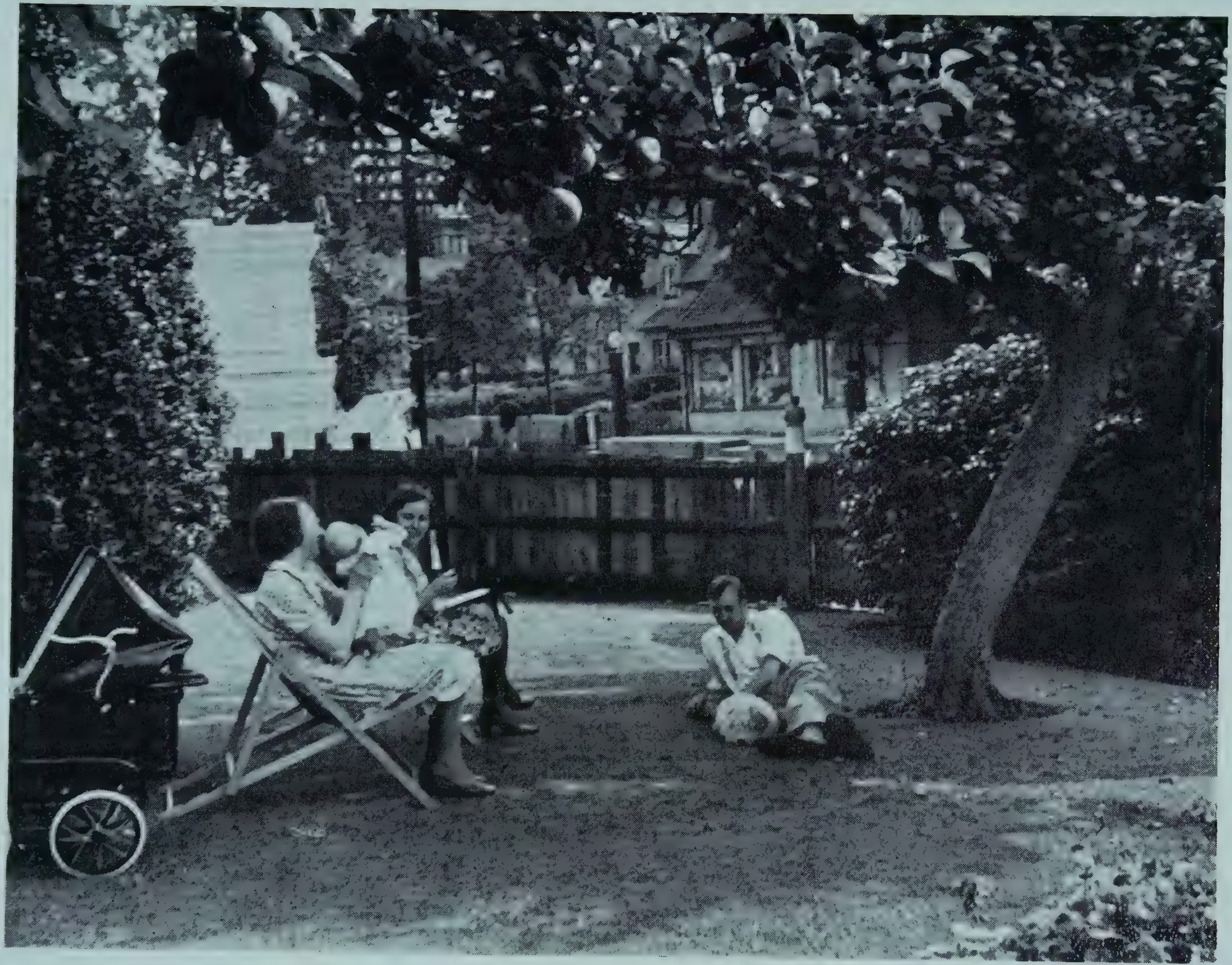


Fig. 130.—A cottage garden at Papworth village settlement.

undergo them. For post-sanatorium cases, industrial colonies are established, in which a man may ply his trade under hygienic conditions or else learn a new one appropriate to his physical state. The fine flower of the movement for the control of tuberculosis is the village settlement, as at Papworth, Cambridge, Preston Hall, Kent, and Barrowmore Hall, Cheshire, composed of cottages for married men and their wives and families (Fig. 130). The men work at an occupation and are nearly self-supporting. The children are kept under observation from birth onwards in order that any tuberculous tendencies in them may promptly be checked. It is claimed at Papworth that no settlement child has developed the disease in the history of the colony. The tuberculosis colony provides permanent after care for those who have been rendered physically substandard by the disease.

The good purposes of the clinic are by no means exhausted when a patient has been disposed of for domiciliary or hospital treatment. It is equipped with appliances for the maintenance of artificial pneumothorax by refill. It is a centre for subsequent supervision of treated cases who are classified as 'quiescent,' 'arrested' or 'recovered,' depending upon the state of the lesion. A 'recovered' case is one in which there has been freedom from symptoms for a period of at least 3 years. It serves also for the examination of contacts with persons found to be tuberculous. It takes to do with the after-care of cases discharged from hospitals or sanatoria, and maintains touch with the voluntary after-care committees, who endeavour to secure the occupational re-establishment of such cases and attend to the welfare of their families, especially the children. The tuberculosis health visitor plays a valued part in this work.

Good results with children are claimed for the Grancher system in France, in accordance with which children exposed to infection at home are boarded out with peasant families in the country where they may lead an open-air life. A similar boarding-out system is employed by some local authorities in England. In large local authority areas children's sanatoria can be established. At such institutions every facility is provided for orthopaedic and rehabilitation treatment to meet the physical needs of the children. At the same time their mental development is promoted in the sanatorium school, which is conducted on the open-air plan and with the hours of instruction tempered to their infirmities.

The medical inspection in schools gives the opportunity of discovering tuberculosis in children. The pasteurisation of milk is preventive of it. In industry the silicosis and asbestosis schemes are further examples of measures adopted for the control of the disease. All influences which make for social betterment are repressive of tuberculosis.

The problem of segregating infective young adult cases who are under domiciliary treatment, or attending a clinic, or awaiting admission to a sanatorium is now causing some concern to public health authorities. Among the plans suggested for their accommodation is that of converting large empty houses into hostels for their use. Each would be under the charge of a warden, perhaps himself a patient, who would be responsible for discipline and the maintenance of a hygienic *régime*.

Among recent developments in tuberculosis control is the detection of the disease at early stages by Mass Miniature Radiography. The British apparatus (Fig. 131), which may be static or mobile, employs 35 mm. film to photograph the image produced by the x-ray on a fluorescent screen, and chest skiagrams can be taken at the rate of 120 persons to the hour. Initially confined to Service personnel, the application of the method is rapidly being extended, and already civilian units are in operation. The cost per photograph has been reckoned as 1/50th of that of standard film. The chief value of the method lies in its facility for mass examination. The approved unit comprises x-ray installations of simple construction for both miniature and standard films, waiting rooms and dressing cubicles, examination rooms, photographic dark room, viewing apparatus and offices. The medical officer in charge, who should be trained in tuberculosis, is assisted by radiographers, positioners and clerks. The miniature films are not intended to be fully diagnostic, or to replace normal roentgenograms, but are designed to bring to notice those individuals who require a full investigation by the usual methods. On this understanding, mass miniature radiography takes a key place in the scheme of tuberculosis control. As the system develops it will be necessary to link up the unit with observation beds and treatment centres. Sixteen Mass radiography units had been installed in Britain by the end of 1944, of which 4 were in Scotland.

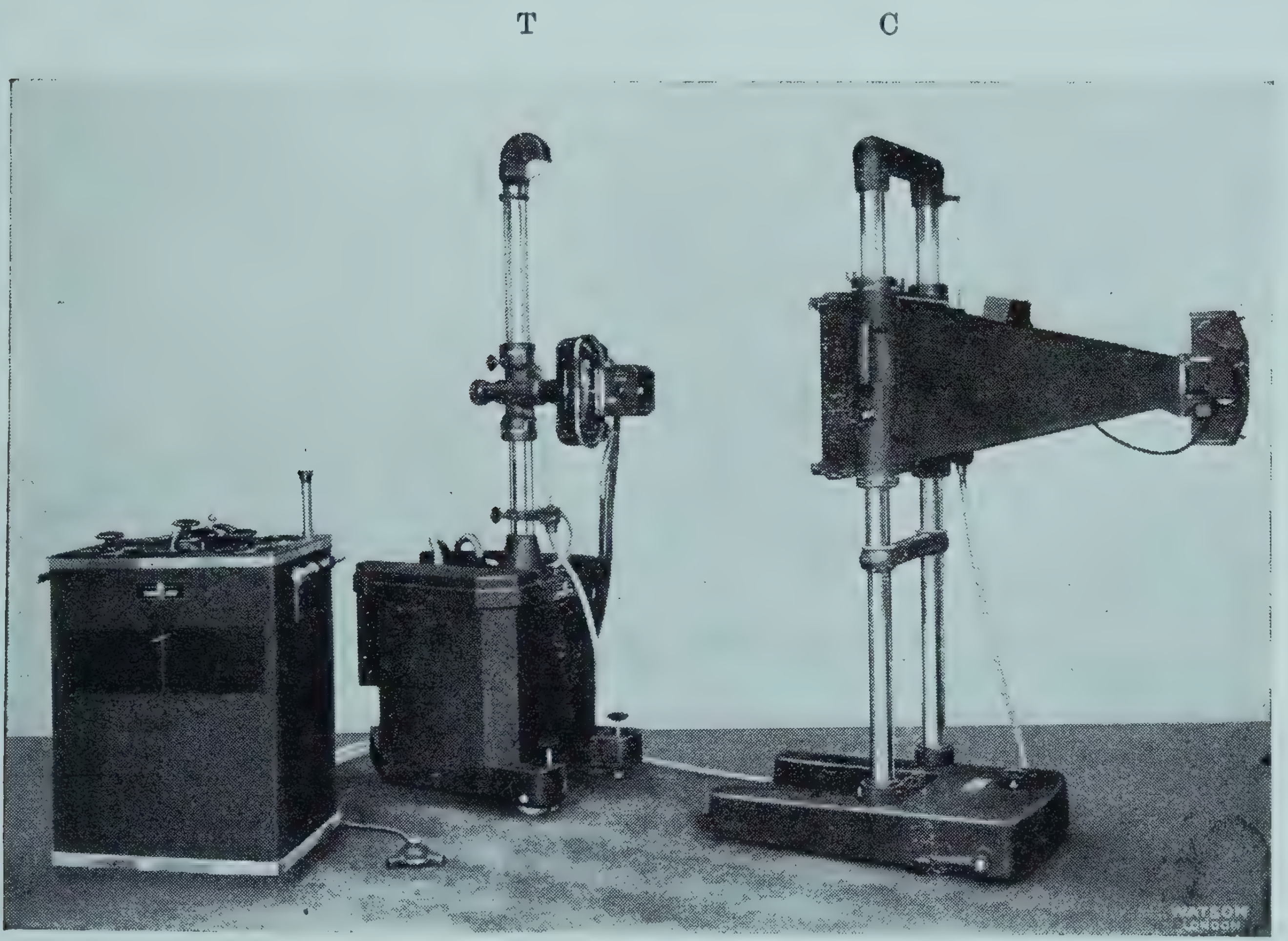


Fig. 131.—Mass Miniature Radiography outfit.

Patient stands between x-ray tube (T) and camera (C).

So far, the incidence of adult phthisis, as revealed by the miniature camera, has lain between 0·5 and 2 per cent. It is intended in the future to apply the process to factory personnel, children leaving school, university students and other groups.

Single examinations by the miniature method are not now regarded as conclusive and it has been suggested that serial examinations at intervals of, say, 6 to 12 months should be the rule.

Special allowances and grants are now made to men and women whose treatment will mean an interruption to earning, and who would otherwise forego necessary hospital or other *régimes* on account of financial anxiety regarding the maintenance of home or dependants. The allowances are payable from local authority funds and they continue so long as the patient follows the course of treatment prescribed by the tuberculosis officer. Treatment may be taken at home, at the tuberculosis dispensary, in hospital or at a sanatorium. The payments are of three kinds :

(1) *Maintenance Allowances.* Where the applicant is a householder, which for this purpose includes a person living in lodgings, rooms or a hostel, the standard scales are as follows.

	Per Week	
	s.	d.
(a) For male applicant and wife, or female applicant with dependant husband (jointly)	39	0
(b) For male or female applicant where rate (a) does not apply	27	0
(c) For dependants (other than wife or husband)—		
Aged 16 or over	12	0
Aged 14 and under 16	8	0
Aged 10 and under 14	6	6
Aged under 10	5	0

Where the applicant is a person living as a non-dependant member of a parent's or other relative's household, and is receiving treatment at home, the allowance will be 25s., with additional payments, if the person has dependants, as in (c) above.

These scales are subject to be increased by the amount of the patient's rent, up to 15s. per week, and by a winter fuel allowance of 3s. 6d. per week. National Health Insurance benefits, monies derived from public fund pensions and special allowances made by employers are deducted from the scale payments. A charge of 10s. per week is also made against the scale when the patient is resident in an institution.

(2) *Discretionary Allowances.* Additional payments may be made at the discretion of the local authority to patients in receipt of maintenance allowances when it is clear that certain liabilities cannot be met without such help. These include rent charges exceeding 15s. per week, hire purchase instalments, educational expenses and life assurance premiums. Discretionary payments will not ordinarily exceed 10s. per week.

(3) *Special Payments.* These are additional discretionary allowances made to meet the travelling expenses of near relatives who visit the patient in hospital, to cover the cost of domestic help when the patient is a housewife and to provide pocket money not exceeding 5s. per week for patients in hospital who are without dependants.

The administrative control of tuberculosis is summarised (Fig. 132). It is likely, in the new national health service, that tuberculosis schemes will be regionalised. Whether or not, the need will remain clamant for more nurses, for many additional tuberculosis health visitors, for more trained social workers, for a fuller rehabilitation programme and for an expansion of the village settlements. It must not be forgotten, moreover, that enlightened infant and school medical services,

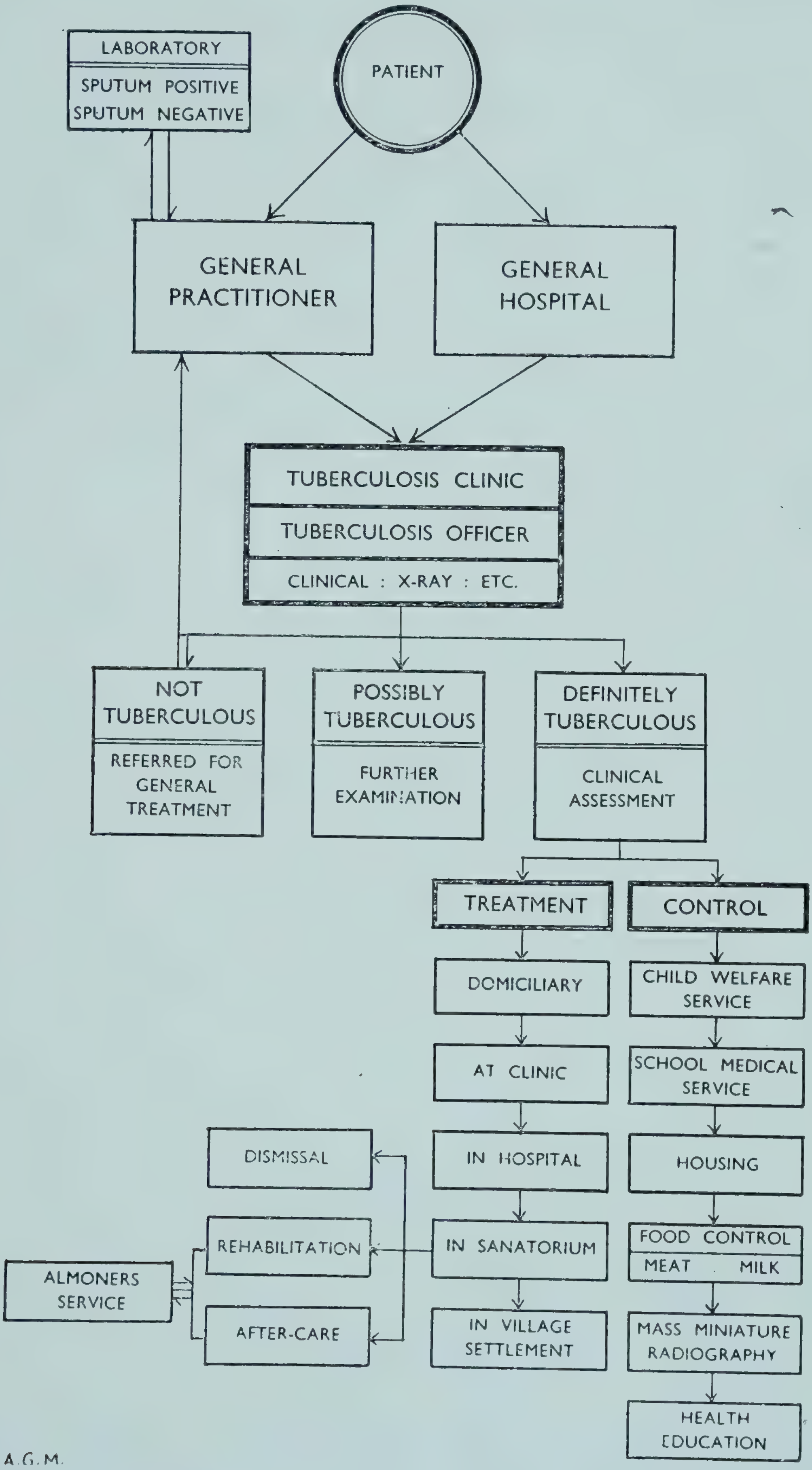

LABORATORY
SPUTUM POSITIVE
SPUTUM NEGATIVE
PATIENT
GENERAL PRACTITIONER
GENERAL HOSPITAL
TUBERCULOSIS CLINIC
TUBERCULOSIS OFFICER
CLINICAL : X-RAY : ETC.
NOT TUBERCULOUS
REFERRED FOR GENERAL TREATMENT
POSSIBLY TUBERCULOUS
FURTHER EXAMINATION
DEFINITELY TUBERCULOUS
CLINICAL ASSESSMENT
TREATMENT
DOMICILIARY
AT CLINIC
IN HOSPITAL
IN SANATORIUM
IN VILLAGE SETTLEMENT
CONTROL
CHILD WELFARE SERVICE
SCHOOL MEDICAL SERVICE
HOUSING
FOOD CONTROL
MEAT
MILK
MASS MINIATURE RADIOGRAPHY
HEALTH EDUCATION
DISMISSAL
REHABILITATION
AFTER-CARE
ALMONERS SERVICE
A.G.M.

Fig. 132.—Scheme of Tuberculosis Control.

adequate and proper housing, pure food and sound factory conditions constitute a *sine qua non* for the success of the tuberculosis campaign.

Tularaemia

Tularaemia, or Deer Fly Fever, is a communicable disease which up to 1926 had appeared altogether in 24 states of the North American Union. The micro-organism is *Bacterium tularense*, which sets up an enzootic bacteriaemia. Among the animals known to be naturally infected are the Ground Squirrel (*Citillus beechyi*), the Water Rat (*Arvicola amphibius*), the Hamster (*Cricetus frumentarius*), and the Opossum (*Didelphis virginiana*). The disease is specially common in wild rabbits, but sheep, cattle and wolves are also subject. The infection passes to man either by direct contact with the blood or other body fluids of the animals or by means of the intermediary bite of a blood-sucking insect or arachnid. The natural insect vector is the Deer Fly, *Chrysops discalis*, which conveys the contagium mechanically by its mouth parts. The natural arachnid vector is the wood tick, *Dermatocentor venustus*, which, once invaded, may become a life-long reservoir of infection and also hand down the infection to posterity. In fly- or tick-bitten human cases the resulting disease is ulcerous, a necrotic eschar with swelling of the regional lymphatics showing at the site of puncture. The incubation period is 3 to 10 days. In cases infected by way of the hands, as in skinning or dressing rabbits, the illness assumes the aspect of typhoid fever, from which it can often be distinguished only by the absence of the Widal reaction for B. typhosus and its congeners and the presence of the corresponding agglutination for B. tularense. Most laboratory workers inoculated in North America through handling in life or examining *post mortem* infected guinea pigs, rabbits or mice, have shown the typhoid type. Laboratory infection has occurred in England also. The case mortality of the disease, over all, is not high. Death, when it occurs, takes place in three or four weeks. In cases which recover, convalescence is usually slow, lasting it may be up to a year. The treatment of the disease is symptomatic. No specific vaccines or sera are available but sulphanilamides appear to be of service. Rubber gloves should be worn by laboratory workers and by persons handling rabbits or other rodents for any purpose in enzootic areas.

Tularaemia has been reported also from Russia and Japan. In Scandinavia it is known as lemming fever.

Typhoid Fever

P. Bretonneau of Tours in 1820 was the first to identify the typhoid lesions in Peyer's patches. Between 1836 and 1840 typhoid fever was recognised by several observers as a distinct disease from typhus and relapsing fevers. Its earlier prevalence, though uncertain, was probably of wide extent.

The infection is set up by B. typhosus (*Eberthella typhi*). The distinctive lesion is hyperplasia and ulceration of Peyer's patches. The exanthem is composed of scattered lenticular rose spots which disappear on pressure. They are usually few in number and most in evidence on the abdomen or on the lower chest and back. The onset is insidious. The fever, which is of 3 to 4 weeks' duration, terminates by lysis. A relapse occurs in some 8 per cent. of cases. The course of a typical attack may be summarised as under:

First Week. Malaise. Anorexia. Sickness. Epistaxis. Some diarrhoea.

Second Week. Diarrhoea severe. Yellow-ochre coloured stool. Crops of rose spots.

Third Week. Typhoid state. Cholecystitis. Peyer's patches necrotic. Haemorrhage or perforation with attendant imminent danger.

Fourth Week. Lysis in favourable cases.

The incidence of typhoid fever is greatest from 10 to 25 years of age. The disease may be mild in children and is often severe in the aged. The case mortality ranges from 8 to 20 per cent. Autumn is the season of election. The infection may be conveyed by personal contact, or by water, milk and other foods, especially uncooked foods, or by the agency of flies (Fig. 133). Tropical typhoid, which is generally more severe than in temperate zones, may be attended by constipation rather than diarrhoea, present no exanthem and develop into hypertoxaemia with rapid myocardial degeneration.

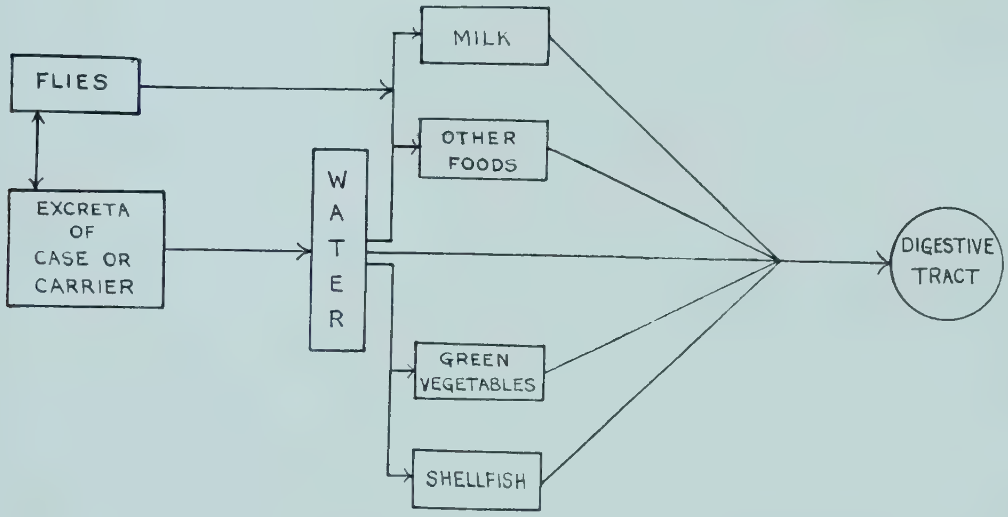


Fig. 133.—Typhoid Fever: Paths of Infection.

The assistance of the laboratory is invariably sought in the diagnosis of typhoid fever. The materials and procedures advised in bacteriological examination are as follows:

First week. Blood Culture. By means of a serum syringe, 10 ml. of blood should be withdrawn from the basilic vein and transferred immediately to a blood culture bottle containing the selective ox-bile medium. The bottle has a perforated metal cap fitted with a rubber diaphragm through which the blood needle is pushed, so obviating the removal of the cap.

Second week. Widal Test. The material for this test consists in 5 ml. of venous blood sent to the laboratory in a screw-cap 'universal' container. Three agglutinins are demonstrable in the blood of a case of typhoid fever, corresponding to the antigens of the bacillus. They are the flagellar or H agglutinin, the somatic or O, and the Vi which is associated with the presence of the living virulent bacillus. The diagnostic titres are 1 in 60 or over for H and O, and 1 in 10 or over for Vi. The agglutinins are demonstrable also in the serum of persons previously inoculated with anti-typhoid vaccine. Generally speaking, the H agglutinin in such cases is stronger than the O: there is, in the absence of an attack of the fever, no titre rise: and the Vi agglutinin is not demonstrable. Should an attack supervene the titre rise becomes apparent, beginning from the relatively high agglutinin level created by the inoculation, and Vi agglutinins appear.

Third week. Excreta Culture. Faecal specimens should be transmitted to the laboratory in 'universal' containers. When transit delay is inevitable the stool may be mixed with an equal volume of 30 per cent. neutral glycerin in saline. Isolation of the bacillus is aided by the use of the special desoxycholate medium. Alternatively a rectal swab may be employed to collect the material, especially with children. Urine specimens, obtained by catheter, should be sent in sterile screw-capped four ounce bottles.

Many outbreaks of typhoid fever have been occasioned by carriers. From 2 to 5 per cent. of cases discharge the bacillus after recovery, and a number of people are found to be carriers without having passed through a recognised attack. The carrier state in typhoid may persist for months or years. It is specially dangerous when present in those who work in dairies or are otherwise employed in the handling of food. At a public dinner in California a pan of spaghetti prepared by a carrier infected ninety-three persons. In the urinary carrier the habitat of the organism is the kidney. In the faecal carrier, who is the more frequent type, the bacillus is localised in the gall bladder and bile ducts, following cholecystitis. The carrier state is proved by the isolation of B. typhosus from the excreta, and is suggested by the presence in the blood of Vi agglutinins up to a titre of 1 in 10. Women, who are more subject to gall bladder disease than men, form 80 per cent. of chronic typhoid carriers. The principal remedy for the condition is surgical. The operation which has given the best results is cholecystectomy. Lately some success has been claimed to follow the administration of iodophthaline. Carriers in domestic circumstances should maintain a strict standard of personal hygiene. The excreta of the carrier should be retained for 2 hours in a 1 in 20 solution of carbolic acid before disposal into the drainage system. Other members of the carrier's household should be immunised with the specific vaccine. The measures which may be adopted for the control of carriers who are a danger to others in the community are noted elsewhere.[1]

Typhoid vaccine is effectively employed to produce active immunity against typhoid fever. It was turned to account for the protection of our troops during the First World War. The official preparation known as T.A.B. is composed of killed cultures of *B. typhosus*, *B. paratyphosus A*, and *B. paratyphosus B*. Thanks to its use, aided by the chlorination of water, the annual incidence of typhoid in our armies during the First World War was 2·35 per thousand of strength as contrasted with 105 per thousand in the South African War. In civil life anti-typhoid vaccination is to be recommended for fever nurses, British people going abroad and home contacts. Two injections are given, the first of 0·5 ml. and the second of 1 ml., with ten days between. Slighter amounts are used for women and children. The alcoholised Felix vaccine, containing Vi antigens and effective in smaller doses, is claimed to produce a more specific antibody response. The T.A.B. preparation may be combined with *V. cholerae* vaccine for use in the Far East. There is no case at present for the employment of T.A.B. in this country on a community basis.

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[1] Page 425.

The *Paratyphoid Fevers* have as their causative agents *B. paratyphosus A,* and *B. paratyphosus B.* Paratyphoid A fever is mainly tropical in its distribution and often very severe. Of the numerous carriers of the infection 4 per cent. are urinary. Paratyphoid B fever resembles typhoid fever in its course. It is conveyed to man more frequently by food than by water. The B organism is responsible also for a food poisoning type of fever and a choleraic form. It is capable in addition of infecting animals. In the Widal test for paratyphoid A the diagnostic titre is 1 in 30 upwards, for paratyphoid B 1 in 120 upwards.

The treatment of typhoid and the paratyphoid fevers is mainly dietetic. *Eberthella typhi* does not respond either to sulphonamide or to penicillin therapy. The Vi antiserum of Felix is effective against typhoid fever only.

In the nursing of a case of typhoid or paratyphoid the concurrent disinfection of excreta, as detailed above,[1] is essential throughout the illness.

Other community measures for the control of the typhoid group of fevers include the boiling of domestic drinking water, or the chlorination of public supplies, the pasteurisation of milk and ice cream, the disinfection of shellfish, thorough cooking of vegetables and the repression of flies.

Typhus Fevers

Typhus, Gaol, or Camp Fever, is a disease of temperate climates. Its symptoms in Italy in 1505 and 1528 were described by Fracastoro. As gaol fever, typhus occasioned the six Black Assizes of England: at Cambridge in 1522, at Oxford Castle in 1577, at Exeter in 1586, at Taunton in 1730, at Launceston in 1742 and at the Old Bailey in 1750. Its activities in time of War are noted under 'Epidemiology.' It is prone to occur in winter and spring. Its effective agent is *Rickettsia prowazeki.* It is conveyed to man by the body louse.

The disease has a slow or sudden onset with headache and vomiting. The eyes are pink and watery, the features turgid, the mind confused, the tongue dry and brown and the limbs hyperaesthetic. Epistaxis is a feature of some outbreaks and fulminant cases attended by violent delirium occur from time to time. The exanthem appears on the fourth day of illness. It begins with spots, not unlike those of typhoid fever, which disappear on pressure. Soon however they darken in colour and become fixed in the skin. In addition the skin is suffused with a dusky-red subcuticular mottling, the tint resembling that of the mulberry. The rash is generalised on the trunk and limbs, the face being normally free. Death takes place about the fourteenth day, or else there is a slow crisis followed by a rapid recovery. Case fatality varies from 10 to 40 per cent. One attack confers lasting immunity.

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[1] Page 432.

Treatment is symptomatic. There is no strictly specific therapy but intravenous mercurochrome, 'soluble 220,' has given good results in typhus fever as well as in the kindred Rocky Mountain Spotted Fever. Lately preparations containing vitamins B_1 and C have been used with some success. The Weil-Felix reaction is the agglutination of *B. proteus* OX 19 by the patient's blood serum after the 10th day of illness. Though not specific, it is accepted as of diagnostic value at a titre of 1 in 100 upwards. The urine of typhus cases gives a marked diazo reaction.

The essential of prophylaxis in hospital is the delousing of the patient and the delousing or destruction by fire of his clothing. Physicians, nurses, attendants on the sick and members of the ambulance staff should wear one-piece suits of tough textile, drawn over the shoes, tied at the neck and having cotton gloves stitched into the sleeves: or else the *Combinaison Hermétique*.[1] A prophylactic vaccine prepared from rickettsiae cultivated in the yolk sac of fertile hens' eggs is now available for personal protection. It is modified by formolisation and administered in 3 doses. Persons resident in endemic areas should be re-vaccinated at intervals of 6 months. Work with this and other rickettsial vaccines is still proceeding. For home contacts and their clothing delousing is essential. Disinfestation of the premises should also be carried out. Experience during the Second World War has shown that the best results are achieved when the duties of control are assigned to 'typhus teams' of trained medical and scientific personnel.

Typhus fever, once common in Britain, is now rare to the point of disappearance. It is however still endemic in other European countries, and in addition is recognised to be related to kindred endemic fevers in distant parts of the world. The Tabardillo of Mexico is a fatal form of typhus due to a strain of *R. prowazeki*. Brill's Disease in the United States and the Fièvre Boutonneuse of Tunis and Algeria are on the other hand mild varieties, as are also the two forms of Tropical Typhus in Malaya.

Murine typhus, similar to, though milder than, the classical form of the disease, occurs in temperate, subtropical and tropical regions. The incubation period is 12 days. The pathogen is a strain of *R. prowazeki*. The vector is the rat flea, *Xenopsylla cheopis*. The Weil-Felix reaction is positive after the 9th day. Rat suppression is an important measure of control. Murine typhus is known also as endemic typhus.

Rocky Mountain Spotted Fever occurs from April to June in Western States of the North American Union, centring on Idaho, Montana and Wyoming. The disease is also found in parts of South America. The attack begins with chills, photophobia, joint pains and malaise, succeeded by delirium with temperature rising to 105° or 107° F.

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[1] Page 476.

About the third day a spotted eruption shows on the wrists, ankles and back and rapidly spreads. It becomes petechial and in dependent parts confluent. The Weil-Felix reaction is positive with *B. Proteus* OX_{19} and OX_2. Death may occur about the tenth day. Case mortality ranges from a low figure in Idaho to 90 per cent. in Montana. A constant complication, which distinguishes the disease from typhus, is haemorrhage into the genitalia, with gangrene of the scrotum and prepuce. The virus, *Rickettsia rickettsi,* produces scrotal inflammation in guinea pigs. The natural tick vectors are the dog tick *Dermacentor variabilis,* the wood tick *D. andersoni,* the lone star tick *Amblyomma americanum* and, in Brazil, *A. cajennense.* Prophylactic rickettsial vaccines are now available. General measures of control include tick suppression.

Asiatic Scrub Typhus resembles Rocky Mountain fever in its clinical picture with, in addition, pneumonic symptoms. Some 6 per cent. of the cases are fatal. The Weil-Felix reaction is positive with *B. proteus* OXK but not with OX_{19} or OX_2. The vector is the larval form of the mite *Trombicula akamushi.* Rats and mice act as reservoir hosts of the pathogen, which is *Rickettsia orientalis.* Control measures include the destruction of scrub by flame throwers. Bedding should be kept well above the ground.

Australian ' Q ' Fever is due to *Rickettsia burneti* and is characterised by symptoms of atypical pneumonia. The vector is a tick.

Undulant Fevers

These fevers are infections set up by organisms of the genus Brucella. The illness follows a relapsing course with non-febrile intervals of varying length. The incubation period is from 6 to upwards of 30 days. Arthritis with effusion occurs and the spleen is enlarged. Profuse sweats are characteristic. The average duration is 4 months, but some cases recover in 3 weeks while others may last for 2 years. Mental depression occurs as a sequela. Diagnosis is confirmed by the recovery of the specific Brucella from the blood and by the demonstration of specific agglutinins in adequate titre. Two types of the disease are recognised. They are known as (1) Malta Fever and (2) Abortus Fever.

Malta Fever, due to *Br. melitensis,* was observed among British troops in Malta. It is an enzootic of the goat. It is conveyed to man in goat's milk, and also by contact with the animal as happens in the case of goat-herds. The agglutination test with *Br. melitensis* is regarded as positive at 1 in 500 upwards especially with a rising titre. Cases occur round the Mediterranean coasts, whence the alternative name Mediterranean Fever, as well as in India, South America and the United States. The South African type of the fever, with its sweats and emaciation, simulates tuberculosis.

Abortus Fever is occasioned in man by *Br. abortus,* which is the specific agent of contagious abortion in bovines, and also of an enzootic in pigs. It is conveyed to man in cow's milk and cream, but more often by direct contact with the living animal as in cow-herds, or with its carcase after slaughter as in the case of butchers, pig-killers and employees in packing houses. The high infectivity of the organism is evidenced by the frequency with which it infects laboratory workers. The disease is common in the United States and cases occur in this country also. The agglutination test with *Br. abortus* suspensions is taken as positive with titres above 1 in 100.

Treatment is mainly symptomatic. Good results have in some cases followed sulphonamide therapy and the antimonial drug Fouadin is also claimed to be remedial. The injection of 500 ml. of convalescent whole blood is stated to have an ameliorating effect upon the symptoms.

Among the preventive measures which may be employed are the slaughter of herd animals reacting positively to the animal agglutination test, and the pasteurisation of milk, butter and cheese. A vaccine for the immunisation of calves is still on trial.

Venereal Disease

The venereal diseases of this country are syphilis, gonorrhoea and soft chancre.

Syphilis, either acquired or congenital, has been estimated to affect some 10 per cent. of the people in large cities and to occasion 10 per cent. of the prenatal deaths. In rare instances the infection is acquired from towels or similar sources, but the pathogen is short-lived when outwith the body. The primary lesion, or chancre, develops at the site of inoculation some 4 to 6 weeks after infection. It heals without treatment and is followed about 2 months later by the secondary stage of the disease which, in typical cases, is attended by pharyngitis, maculopapular rash and alopecia. The onset of the tertiary lesions, which include ulceration, gummata and cardiovascular degeneration, including aneurysm, may be delayed for many years. Among the late manifestations of neurosyphilis are general paralysis, optic atrophy and locomotor ataxia. Syphilis may remain long latent before symptoms appear. Tertiary cases may never have shown the primary and secondary stages. Man does not appear to have any natural immunity to the disease, nor does one attack protect against subsequent infections. The introduction of specific arsenical therapy has, by shortening the period of infectivity, led to a marked decline in the incidence of lues. When introduced into populations of high susceptibility, syphilis may assume epidemic proportions, as at Hawaii and in Uganda. Congenital syphilis may be responsible for mental deficiency, interstitial keratitis, optic atrophy or nerve deafness. Syphilis of pregnant women is responsible for a large number of abortions and still births.

The diagnosis of syphilis is confirmed by the dark field demonstration of *Treponema pallidum* in the exudate from a chancre or fluid obtained by gland puncture or from the secondary rash. Care should be taken to exclude blood from material intended for dark field examination. The Wassermann complement fixation test, the Kahn flocculation reaction and the Meinicke clarification test (Fig. 134) are applied to blood and spinal fluid both in diagnosis and in controlling treatment. The quantitative Meinicke procedure as developed by Ford-Robertson at Glasgow promises to be of value in the latter connection.

The arsenicals for the treatment of syphilis include neokharsivan novarsenobillon, acetylarsan and arsphenamine. Tryparsamide is of service in the treatment of neurosyphilis. Intravenous medication is combined with the intramuscular injection of metallic bismuth and in later cases also with the oral administration of potassium iodide and mercury. Penicillin has given excellent results in primary syphilis and has largely been employed among service personnel. It is yet too early to determine the efficacy of the drug in later stages of the disease. L. W. Harrison has recently expressed the view that penicillin should be combined with an arsenical in the treatment of syphilis. Hepolon and sodium thiosulphate are of value both in arsenical jaundice and in the pre-icteric stage, as shown by the presence of urobilinogen in the urine. Thorough treatment of the infected expectant mother will, if timeously begun, ensure a healthy child. Protein shock therapy is of service in cases of locomotor ataxia, while induced malaria may arrest the progress of general paralysis.

Gonorrhoea on the information available is more prevalent than syphilis in an estimated proportion of 7 to 1. Among its sequelae in males are urethral stricture and, in females, sterility. As the source of gonorrhoeal ophthalmia in infants it has been held accountable for 25 per cent. of all cases of blindness. Outbreaks of gonorrhoeal vulvovaginitis may occur in children's wards from lack of scrupulous cleanliness with regard to towels, utensils and the like.

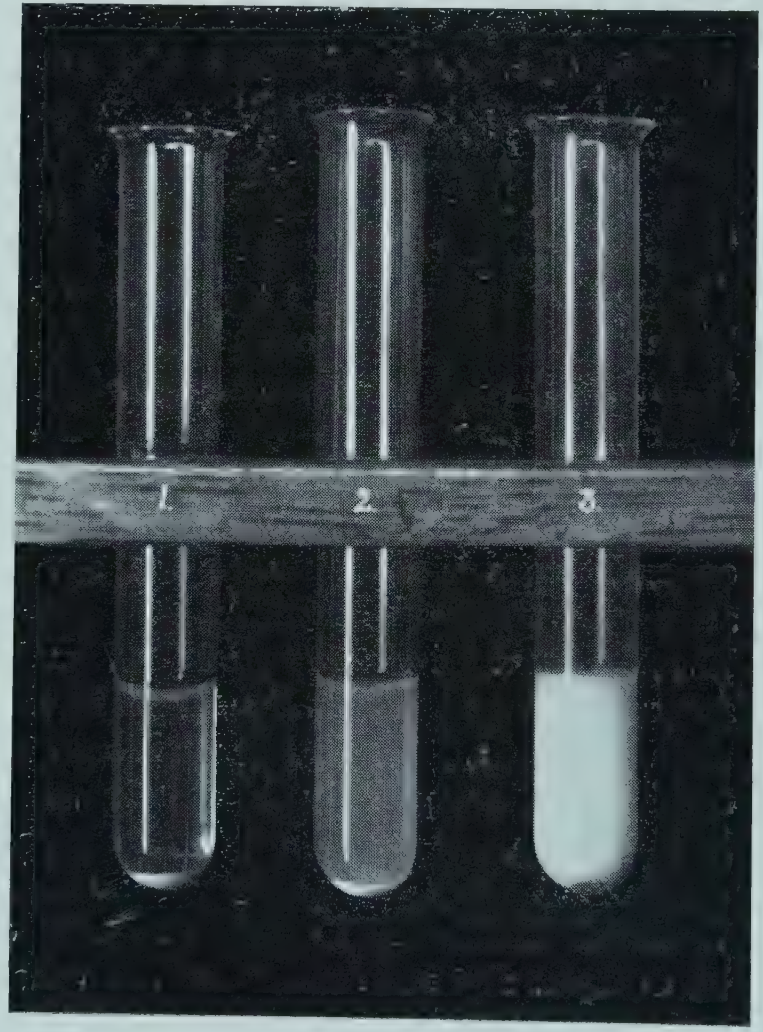

Fig. 134.—Meinicke Test.
1. Positive Reaction. 2. Doubtful Reaction. 3. Negative Reaction.

The diagnosis of gonorrhoea is usually sufficiently confirmed by the microscopical demonstration of gonococci in a smear from the urethral or cervical discharge. Culture methods for gonococcus may be used in doubtful cases, especially in prostatic infections, and a complement fixation test is available.

The treatment of gonorrhoea is now by penicillin, which in successful cases cures the disease in a few hours. The drug is given intramuscularly in 5 injections each of 30,000 Oxford units, separated by 2 hour intervals. Alternatively a single dose of 200,000 Oxford units in arachis oil and beeswax may be given. In the case of patients whose employment does not permit their attendance for intensive treatment, recourse may be had to the sulphonamides, notably sulphathiazole and sulphadiazine. The course for an adult is 5 grams daily for one week, given either alone or along with urethral irrigation by potassium permanganate in dilutions up to 1 in 10,000. For gonorrhoeal vulvo-vaginitis in children the dose of sulphonamide should be 0·5 gram six hourly for 5 days, with half doses for infants. Surgical diathermy and gonococcus vaccines have a place in the treatment of chronic cases. Imperfectly treated gonorrhoea is the cause of much ill health in both sexes. Medical officers should in this connection appreciate the need for a searching 'test of cure' before dismissing gonorrhoeal patients. Such tests are best carried out by a specialist. The test of cure is of particular importance in the case of female patients and should be performed every 4 weeks for 3 months. It should include the examination of smears from urethra and prostate, or cervix and vagina and, where indicated, from the rectum, as well as urethroscopy.

Soft Chancre is localised and may heal spontaneously, but vaccines of the Ducrey bacillus will hasten recovery, and sulphanilamide is also remedial. The diagnosis of soft chancre is usually made on clinical evidence, as it is difficult to demonstrate the causative micro-organism.

The control of venereal disease is carried on by local authorities in England and Wales under powers conferred upon them by the Venereal Diseases Regulations of 1916. They are authorised (1) to provide facilities for the examination of material from suspected cases of venereal disease sent in by practitioners, (2) to give confidential treatment of venereal disease, free of charge, in hospitals or institutions, (3) to supply practitioners with the arsenicals for treatment, and (4) to incur expenditure with a view to the spread of relevant information. The arrangements made require the approval of the Minister of Health. The Venereal Disease Act of 1917 makes it penal in any area, where an approved free treatment scheme is in operation, for any person other than a qualified medical practitioner to treat venereal disease, and also forbids under penalty any advertisement or announcement by any unqualified person offering to give treatment for venereal disease.

Precisely equivalent Regulations are in force in Scotland. The Venereal Disease Act applies to both countries.

Compulsory notification of the venereal diseases, frequently advocated both by professional and lay authorities, has not so far been adopted in this country. Opponents of the practice believe that the necessity to declare infection would lead to concealment. Experience of notification in other countries scarcely supports this view. Swedish legislation for example compels the notification and treatment of venereal disease and imposes a penalty upon those who cease to attend for treatment before being pronounced infection-free. As a result of these measures the incidence of acquired syphilis in the country fell from 4·3 per 100,000 of population in 1915 to less than 1 per cent. per 100,000 in 1935. In any event, compulsory notification must be followed by compulsory treatment if any real advance is to be made.

Regulation 33B of the Defence (General) Regulations, 1939, provides for the compulsory treatment of venereal diseases in certain cases. Its object is to bring under medical care infected persons who, on account of refusal to undergo treatment, constitute a community danger. Special practitioners are required to send, in strict confidence, to the Medical

Officer of Health a notice giving the name and address of any person (referred to in the Regulation as a 'contact') who is suspected of having transmitted venereal infection. Should it appear to the Medical Officer of Health, from such a notice or notices received, that the contact is under suspicion of having infected two or more persons, it is his duty to require the contact to undergo a medical examination by a special practitioner. If the special practitioner deems the contact to be free from venereal disease he must send to the Medical Officer of Health a 'clearance certificate' in respect of the contact. If on the other hand he finds that venereal disease is present he must serve a 'treatment notice' on the contact requiring the contact to attend and follow his directions until certified free of venereal disease in a communicable form. The penalty on conviction for non-compliance is imprisonment up to 3 months or a fine up to £100 or both imprisonment and fine.[1]

Confidential free treatment is given by local authorities mainly at venereal disease out-patient treatment clinics, the number of hospital beds required being relatively small. It has been conservatively estimated that 80 per cent. of the cases receive their treatment at these clinics. Some of the clinics are separate institutions: others are attached to general or fever hospitals. In either event they should be accessible but inconspicuous. The sexes should, wherever possible, be treated at different clinics or, if in the same clinic, at different hours. Children suffering from congenital syphilis are usually dealt with at women's clinics. Laboratories for diagnostic purposes are a necessary adjunct, but the examination of routine smears is best carried out at the clinic, which should be furnished with a plain and a dark-field microscope and staining reagents for the purpose. Diagnosis and treatment are carried on in the manner above summarised for each of the three diseases. The clinics should be equipped for urethroscopy, diathermy and minor surgery. In cases where the treatment clinic attended by a patient is situated in another local authority area than that in which he resides, his home local authority is at liberty to defray his travelling expenses. Special arrangements exist for infected seamen and other mobile persons, who are provided with the regulation V15 (Fig 135) 'travelling card' by which a record of their treatment is kept as they move from place to place.

It is the experience at most clinics that many patients cease to attend before cure is complete. These defaulters, who may actively disseminate the infection, present a problem for which several solutions are on trial. In one city a reminder is sent by post to the defaulting patient, his consent having been received to this being done in the event of his ceasing to show up. In another city a similar reminder is transmitted, but without consent asked. A further plan is to arrange with the patient's insurance doctor to send for him and, when he comes to the surgery, to tell him where his duty lies.

The establishment of arrangements for personal prophylaxis by attendance at ablution stations or by the use of preventive packets containing a germicidal application has been found to reduce venereal infection among troops. The proposal that equivalent facilities should be provided by local authorities in Britain for the convenience of civilians has been strongly backed and as strongly opposed. The question involved are not free from difficulty, but our own view is that on balanc the opponents have the better case. The establishment of licenced house

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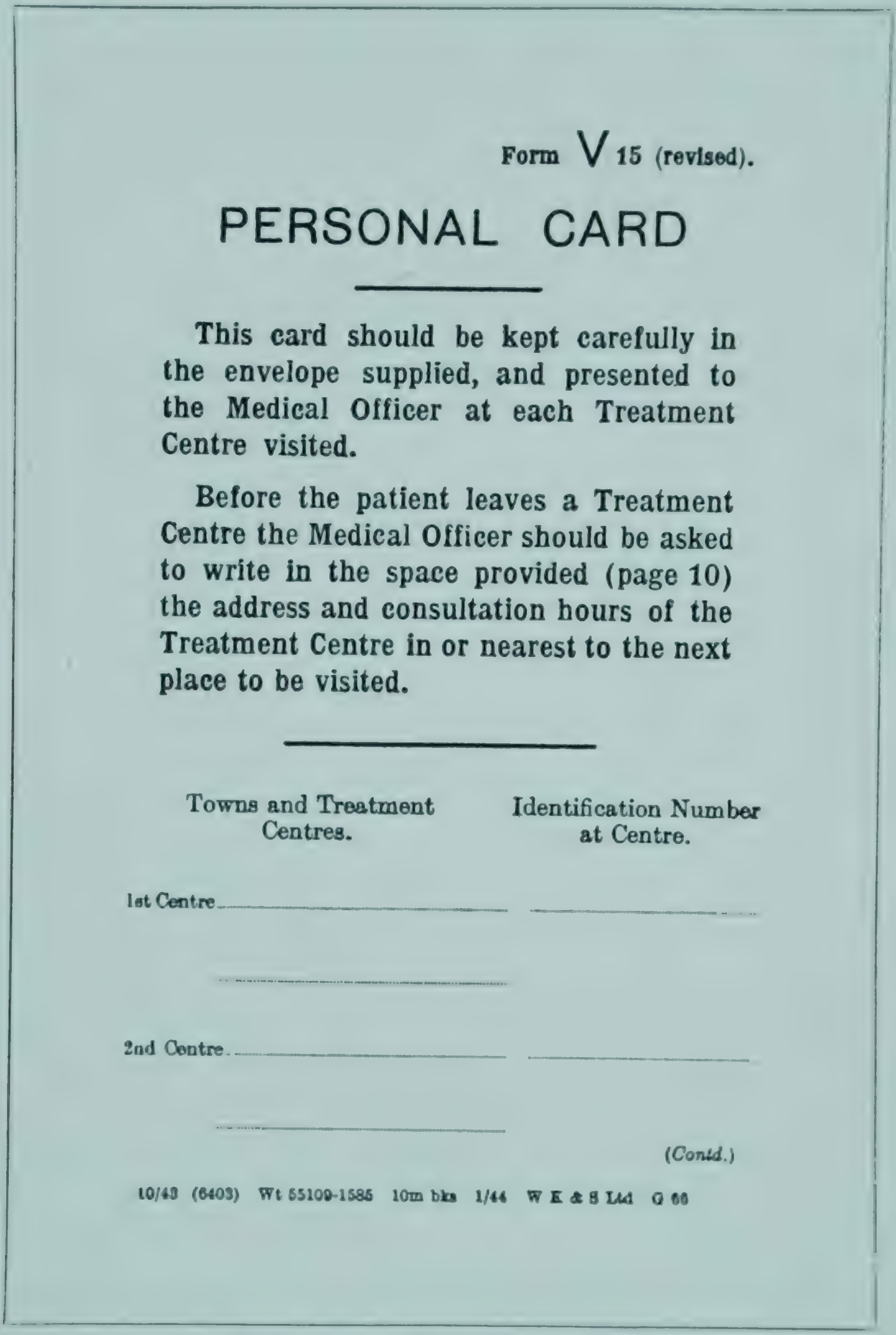
[1] *vide* page 690.



Form V 15 (revised).

PERSONAL CARD

This card should be kept carefully in the envelope supplied, and presented to the Medical Officer at each Treatment Centre visited.

Before the patient leaves a Treatment Centre the Medical Officer should be asked to write in the space provided (page 10) the address and consultation hours of the Treatment Centre in or nearest to the next place to be visited.

Towns and Treatment Centres.	Identification Number at Centre.
1st Centre ______________	______________
______________	
2nd Centre ______________	______________
______________	

(Contd.)

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Fig. 135.—‘ Travelling ’ Card.

is a measure to be condemned as one both revolting to British sensibilities and powerless to arrest the spread of infection.

In the years immediately before the war, returns suggested that, whil the attendances at treatment clinics were maintaining a level, the numbers of new cases were declining. Since the outbreak of hostilities in 1939 there has been a sharp rise in the figures which had, in so far as syphilis is concerned, almost doubled by 1944. Much can be effected towards a reduction of the incidence by the encouragement of athletics and healthy recreations among adolescents, as well as by the work of vigilance associations and women police personnel, but the ultimate lever towards betterment is social progress, which stands among the aims of the British Social Hygiene Council. The Council seeks, among other objects, to preserve and strengthen the family as the basic social unit, to promote social measures for the control of the racial instinct, to emphasise the responsibility of the community for preserving or improving the quality of future generations, to co-operate with the medical officer in the clinics as regards propaganda and to foster social customs which promote a high and equal standard of sex conduct in men and women. The activities of the Council in the field of education and, as regards the general public, by a propaganda aptly utilising the film, the lecture and the brochure, have been widely influential in implanting right understanding and right principles of behaviour in these matters. There is however much need for the expansion of wholesome recreational facilities for the adolescent, for the development of youth organisations, for the provision of many more hostels and clubs for seamen and for the inculcation of habits of temperance in the community at large.

Legislation compelling the medical examination and Wassermann testing of those about to marry is now in force in the Canadian Provinces of Alberta and Saskatchewan and will shortly apply to Prince Edward Island. Similar legislation has also been passed in various parts of the United States. Thirty-two States have in addition laws requiring the Wassermann testing of expectant mothers. Much may be done by such means to secure the timeous treatment of both acquired and congenital syphilis.

Vincent's Angina

Known also as Trench Mouth, and Ulcerative Stomatitis, this infection is due to the symbiotic development in the buccal mucosa of *Treponema vincenti* and *B. fusiformis*. Outbreaks are not uncommon in institutions and among troops. The condition may co-exist with diphtheria. Infection is by direct contact, or from the use of common drinking utensils. Symptoms include sore throat, dysphagia and halitosis, together with enlargement of the neighbouring lymphatic glands. A chronic non-ulcerative form of the disease also occurs. Diagnosis is established by the demonstration of the pathogens in fuchsin-stained smears from the lesions. Good results have been claimed from treatment by sulphathiazole. The causal organisms respond also to penicillin, which should be administered in pastilles.

It should be borne in mind that Vincent's angina may occur as an episode in the course of acute leukaemia, agranulocytosis or other disease of the blood.

Prophylactic measures include the promotion of oral hygiene and the provision of individual drinking vessels among service personnel, especially aboard ship.

Whooping Cough

This infection, known also as Pertussis, is a severe disease of infan and young children. The case mortality in the first year of life is n less than 10 per cent. Of the total deaths, about 90 per cent. occ under the age of 5. Of these, more than half are attributable pulmonary complications. The most fatal months in this country a March and April.

The attack of whooping cough begins with a premonitory stag lasting from a few days to 2 weeks, during which the child seems o of sorts and is troubled by a short dry cough, similar to that whi

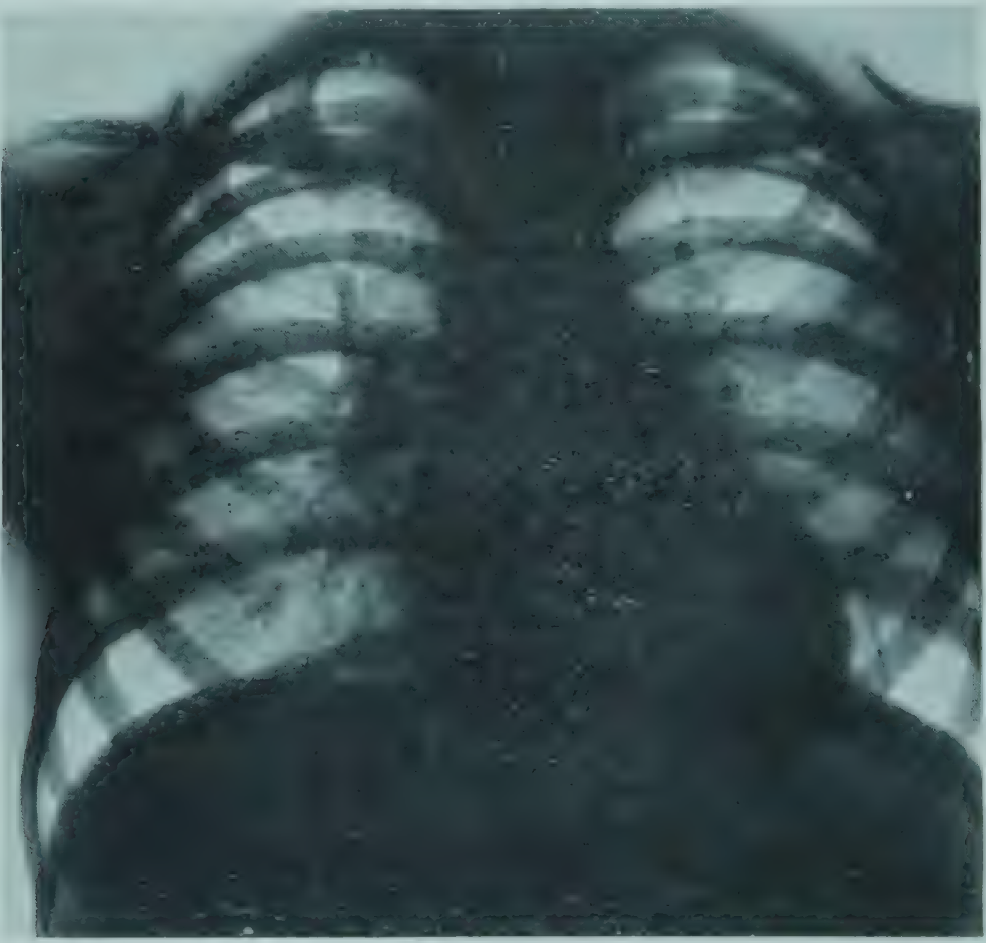

Fig. 136.—Hilar Adenitis as a sequel to Whooping Cough.

Female, aged 6 years: Photograph taken 3 months after recovery from moderate attack. No previous illness

occurs in early measles and laryngeal diphtheria. Then the cou becomes spasmodic, recurring in characteristic paroxysms, in which t face becomes suffused, the tongue protrudes, the saliva is bloodstain and finally vomiting takes place. This stage lasts approximately 6 week being most severe during its second and third weeks. The complicat are epistaxis and sub-conjunctival and other haemorrhages, convulsio hernia, bronchitis and bronchopneumonia, and ulcer of the *fraenu linguae* in children who have cut the two lower incisors. Sequelae a cardiac dilatation and in some cases tuberculosis, to which a persisti hilar adenitis predisposes the patient (Fig. 136).

The treatment is symptomatic. Paregoric may be given for the cou and belladonna is helpful as an anti-spasmodic. Sulphonamides a said to reduce the risk of a fatal termination. Open-air treatment an important adjuvant. As the infection is spray-borne the spacing of beds and the free access of air to wards and sick-rooms are further aids.

The specific organism, B. pertussis (*Haemophilus pertussis*), occurs in four serologically distinct phases of which I and II are pathogenic smooth types. The bacillus is present in the sputum, being most abundant in the early stages. With a view to its demonstration the child should be caused to cough upon a Petri plate, containing the special Bordet Gengou culture medium, held 4 to 6 inches from the mouth. The post-nasal swab may also be used.

Several pertussis vaccines are available for prophylaxis. The original Sauer vaccine consists of killed phase I organisms. Four doses of 1 ml., equivalent to a total of 20,000 million bacteria, are recommended to be given between the ages of six months and two years. A 'boosting' dose may be given at the end of the second year. There should be a week between each of the first three doses and a month between the third and last doses. The duration of protection is not certainly known and the vaccines have proved rather capricious in action. The injections may be followed by moderate reaction. Alum-precipitated antigen, and pertussis toxoid, produced by formolising the toxin, are now on trial and seem, from published figures, to be effective, though not all are agreed upon this point. Preparations containing both pertussis vaccine and diphtheria prophylactic may be employed to confer combined protection. A temporary immunity may be conferred on young children who are at immediate risk, by the injection of convalescent serum.

In England and Wales, under war conditions, whooping cough has been notifiable since October, 1939.

Yaws

This chronic affection, known also as Framboesia, is common in tropical Africa, the East and West Indies, Malaya and the Pacific Islands. The primary lesion is a solitary papule which becomes an ulcer. In the second stage, after a branny desquamation, the characteristic red granulomata, known as 'yaws,' develop. In the tertiary stage extensive ulcers form and may persist for years. The disease is rapidly amenable to treatment with salvarsan. The infective agent is *Treponema pertenue*. Transmission takes place by personal contact and also through the agency of house flies or biting insects.

Yellow Fever

The yellow fever that existed in Central America before the Spaniards came remained endemic round the Caribbean Sea and the Gulf of Mexico. During the nineteenth century it spread more widely, reaching south to Buenos Aires and north as far as Quebec and Montreal. During the epidemic of 1878 in the Gulf states of the Union 16,000 persons lost their lives. In the old world Spain suffered invasion in 1819-21. In the Lisbon epidemic of 1857 there were 5000 deaths. From the work of Aitken, Connal, Gray, Smith and other observers it seems clear that the West African fever is the same as the American. No indigenous cases have, so far, been reported from East Africa, Australia or any place in Asia.

After an incubation period of 3 to 6 days, the onset of yellow fever is typically abrupt, with a soaring temperature, severe headache and racking pains in the back and loins. On the fourth day there is a remission which in mild cases passes on to convalescence. In severe cases the symptoms quickly return. There may be anuria and convulsions. Jaundice develops, whence the descriptive name, and then haemorrhages from the mucous surfaces, signalised by the 'black vomit' of altered blood, which is an ominous sign. Case mortality varies in different outbreaks. It may be up to 80 per cent. The diagnosis of mild cases, especially when remote from laboratories, is often difficult. If albumen is present in the urine it is probably yellow fever.

Persons who recover from yellow fever acquire a lasting immunity, the existence of which may be demonstrated by means of the 'mouse protection test,' inasmuch as their blood, when injected into a mouse, protects the animal against the subsequent administration of yellow fever virus. The test may be used for the purpose of plotting endemic areas. It is possible also to confer immunity upon the human subject by means of a vaccine prepared from the attenuated virus 17 D, cultivated for the purpose in the tissues of developing chicks. The vaccine is put up in dried form in ampoules and is reconstituted by adding distilled water before use. The dried vaccine must be stored at 0° C. until used and should be injected within an hour of reconstitution. A single injection suffices for protection and there is little or no reaction. Immunity is established in a fortnight and may persist for upwards of three years.

The specific agent in yellow fever is a filter-passing virus which may be recovered from the blood in the acute stage. The disease is conveyed to man by the mosquito, *Aëdes aegypti*. Having bitten a patient within the first 3 days of illness, the female becomes capable in 12 days of passing the infection on. The view held till lately that Aëdes was the sole natural vector can no longer be sustained, since the 'jungle yellow fever' of South American States is known to be transmitted by *Aëdes leucocelaenus* and other strains. It is still a question whether biting insects other than mosquitos may assist in the dissemination of the infection. Monkeys and marmosets, and other jungle animals, appear to act as reservoir hosts.

At present yellow fever is endemic locally, between the tropics, on the mainland of the New World. From the Antilles, once its native home, it has been expelled, for the time being at least, largely owing to the activities of the Rockefeller foundation. In Africa the endemi area stretches between latitudes 15° N. and 10° S. It is bounded on the east by the Indian Ocean and on the west by the South Atlantic. Al land within these limits is in the endemic area, excepting Tanganyika and Spanish Guinea. The presence of yellow fever in both the West Indie and West Africa is a legacy of the slave trade. Which of the tw infected the other is in dispute.

The essential prophylaxis of yellow fever is mosquito control. Th international conveyance of the disease is discussed below.[1]

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[1] Page 646.

XX.

INFESTATION

METAZOAN parasites also may invade the body of man or, without parasitising his person, may infest his dwelling or environment to his serious damage. Helminth members of the former group may be directly pathogenic. Included in the latter group are the vector insects and arachnida, together with the rats and mice which act as reservoir hosts of infection and do mischief in other ways.

HELMINTHES

Of the worms which infest man some may be innocuous or their effects sub-clinical: others attract or compel attention by the pain which they occasion or by other indications of profound bodily derangement. Such developments may be owing simply to the presence of the worm as an intrusive object. Thus the expanding hydatid cyst exerts pressure on the viscera, while massed flukes may obstruct the bile ducts and produce cirrhosis of the liver. Wuchereria may check the flow of lymph and cause elephantiasis. Migrant ascarides blocking the larynx may be responsible for suffocation.

Apart from these manifestations, which are of mechanical origin, helminthiasis may be attended by other signs and symptoms significant of tissue reaction. During the invasive stage pyrexia may occur: in later chronic stages asthenia is common. Haemorrhage from the intestine with consequent anaemia takes place in hook worm disease, trichiniasis, and one of the forms of schistosomiasis. Haematuria points to another variety of schistosomiasis, and blood-stained sputum is typical of the lesion produced by the lung fluke. Free haemorrhage from an eroded vessel may be a complication of hydatid disease. Eosinophilia is important in worm infestations. It is a constant feature in the presence of Echinococcus, Diphyllobothrium, Ascaris, Ankylostoma or Trichinella.

Among nervous symptoms of focal origin are the epilepsy of Paragonimus infestation, the blindness and convulsions produced by *T. solium* cysticerci in the brain, and probably the nerve disturbances occasioned by Ascaris larvae. Ground itch is a well-known antecedent of hook worm disease. Another itch of a similar kind is that set up by the cercariae of Schistosoma. Systemic reactions, allergic or anaphylactic, have been observed. Such are the wheals of the skin in hydatid disease, the shock ensuing upon the rupture of a hydatid cyst and the response to the cystic fluid in the Casoni test. Similar tests with antigen derived from embryos are employed in trichiniasis.

Worms which parasitise the intestine yield to treatment with vermicides either readily or with reluctance. Those which inhabit the tissues are strongly resistant to attempts at cure. For the prevention of infestation we are in some ways better equipped. The life histories of the more peccant helminths have been well explored, so that we are in a position to devise appropriate prophylactic measures. For financial and other reasons however it is often difficult to make these measures effective where most required.

Zoological Classification. Each main division of the animal kingdom is a *Phylum*. The principal sub-groups within a phylum are the *Classes*. Main sub-divisions of the classes are the *Orders*. Each order is further divided into *Families* and each family into *Genera*. The various forms within each genus are the *Species*. The house fly, for example, on this system is classified as Phylum *Arthropoda*, Class *Insecta*, Order *Diptera*, Family *Anthomyiidae*, Genus *Musca*, Species *domestica*. Genus names are written with a capital, and species names with a small letter.

PHYLUM PLATYHELMINTHES

Worms which are flattened dorsoventrally. Their bodies are solid, with no conspicuous body cavity, the spaces between the organs being filled with a peculiar parenchyma. The worms are usually hermaphrodite, with complicated reproductive organs and life-histories often involving more than one host.

The worms of the *class* Trematoda are typically leaf-shaped and usually hermaphrodite. They have a ventral as well as an oral sucker and their life history includes one or more intermediary hosts.

Fasciola hepatica, lately *Distoma hepaticum*, the liver fluke, which inhabits the bile ducts of the sheep, is the cause of liver rot, or distomatosis, in that meat animal. The infestation, which is common in this country, entails serious economic loss. It occurs in cattle also but is rare in man. The life history of *F. hepatica*, depicted in Fig. 137, is typical of the trematodes. The egg, deposited in a bile duct, passes to the outer world and, reaching water, liberates the ciliated miracidium. This larval form boring into a water snail, in Britain *Limnaea truncatula*, undergoes in the body of the snail a succession of changes, as a result of which the tailed cercariae are set free. Encysting on grass blades the cercariae develop into young flukes. When the grass is cropped by a sheep the young flukes are conveyed to the sheep's intestine, from which they make their way into the liver substance and there attain adult status. Finally they enter a bile duct and the cycle is complete. A heavy infection of these flukes in the bile ducts may cause serious liver symptoms and even death. Diagnosis depends ultimately on finding the eggs in the faeces. *Fasciola* has been found in other situations in the body, sometimes possibly carried there when young in the blood stream.

Fasciolopsis buskii is similar in morphology and life cycle to *F. hepatica*, but is larger. It is common in Asia in Man and the pig, in the intestine and sometimes in the stomach, causing severe symptoms if numerous. Other species have been described in China and India.

Clonorchis sinensis is the Asiatic liver fluke, common in man, fish-eating Carnivora and pigs in India and elsewhere. Thronging the bile ducts of man it produces liver enlargement. The cercariae encyst in fresh-water fish, from which man contracts the infestation.

Paragonimus westermanii is the Asiatic lung fluke, but it is found also in America. It infests man, the pig, the dog, the cat and wild carnivora. The resulting endemic haemoptysis presents symptoms resembling phthisis, from which it may be distinguished by the presence of the operculate eggs of the fluke in the viscid blood-stained sputum. The cercariae encyst in fresh-water crabs and cray-fish. From these, if they are eaten uncooked, man contracts the disease. Paragonimus may attack also other organs, including the brain, in which case there may be Jacksonian epilepsy.

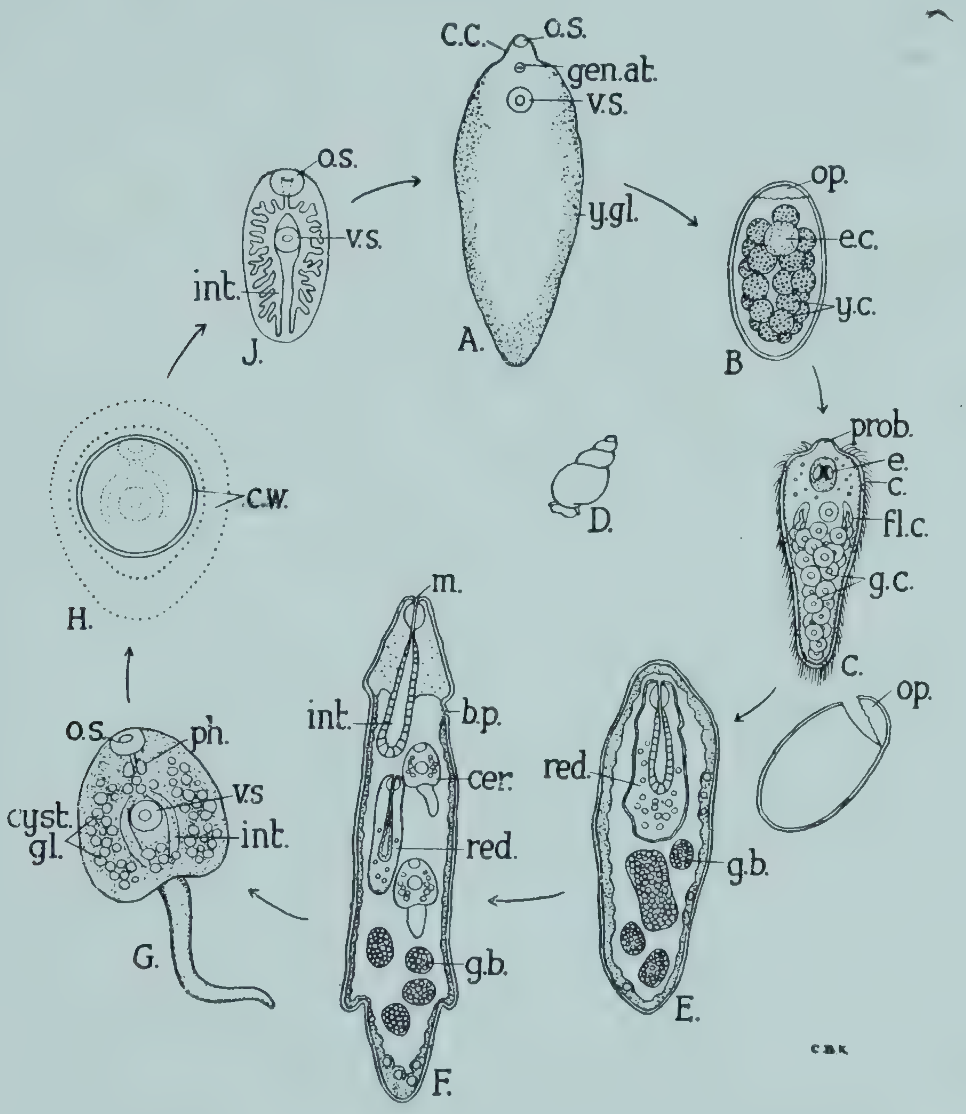


Fig. 137.—Fasciola hepatica.

A. Adult fluke in ventral view; B. Egg; C. Miracidium escaping from egg; D. *Limnaea truncatula*; E. Sporocyst; F. Redia; G. Cercaria; H. Cyst; J. Young fluke.

b.p., birth pore; *c.*, cilia; *c.c.*, cephalic cone; *cer.*, cercaria; *c.w.*, cyst wall; *cyst.gl.*, cystogenous glands; *e.*, eye; *e.c.* egg cell; *fl.c.*, flame cell; *g.b.*, germ ball; *g.c.*, germ cells; *gen.at.*, genital atrium; *int.*, intestine; *m.*, mouth; *op.*, operculum; *o.s.* oral sucker; *ph.*, pharynx; *prob.*, proboscis; *red.*, redia; *v.s.* ventral sucker; *y.c.*, yolk cells; *y.gl.*, yolk glands.

Schistosoma haematobium, formerly *Bilharzia haematobia,* is a blood fluke. It differs from the above-mentioned flukes in being dioecious. The male is ½ inch long: the female ¾ inch. The male, though flat, is involuted to form the gynaecophoric canal and so presents a cylindrical contour (Fig. 138). The worms, which occur only in man, live and pair in the portal circulation. The female lays her terminally spined eggs in the vesical submucosa, setting up an extremely painful cystitis with haematuria. The blood-stained urine carries the eggs to the outer world. A few eggs are laid in the rectal submucosa and pass out in the faeces. The miracidium enters a snail of the genus *Bulinus*. The cercariae, having shed their forked tails, penetrate into the human body, passing usually through the skin, in which they cause itching or erythema. They then travel, mainly in the blood stream, to the liver and portal circulation, where they reach maturity. Schistosomiasis or bilharziasis or endemic haematuria, as it is variously called, is widespread in Africa from Morocco to Egypt and from Egypt southward to Cape Colony. It occurs also in Arabia and Western Australia.

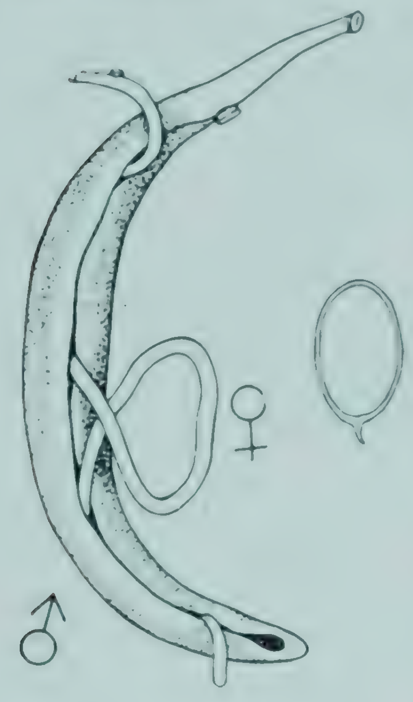


Fig. 138.—Schistosoma haematobium. Male, female and egg.

Schistosoma mansoni is a blood fluke of man, but occurs also in the monkey. The symptoms produced are dysenteric and the eggs are passed in the faeces. The fluke has an extensive distribution on the Nile, Niger and Congo, and in South America.

Schistosoma japonicum occasions Far Eastern schistosomiasis, prevalent among labourers in rice fields, and attended by oedema and ascites, dysenteric symptoms, emaciation and, in later stages, cirrhosis of the liver. In China the disease is called Yangtse Valley Fever.

The differential characters of the three species of schistosomes may be summarised as under:

Species	Vector Snail	Egg	Lesion
S. haematobium	Bulinus	Terminal Spine	Haematuria
S. mansoni	Planorbis	Lateral Spine	Dysentery
S. japonicum	Oncomelania	Lateral Knob	Dysentery

The prophylaxis of schistosomiasis in infested areas should begin, where practicable, with the exclusion of excreta from sources of water supply. The molluscan intermediary is killed off by draining fresh-water swamps and by drying and liming irrigation canals. In the Sudan the afforestation of pond and canal areas with the tree *Balanites aegyptica* has proved fatal alike to molluscs, miracidia and cercariae. Cercariae in drinking water may be disposed of also by two days' storage, by putting the water through a Pasteur-Chamberland filter, by heating it to 120° F. or to boiling point if preferred, or by the addition of sodium bisulphate in 0·1 per cent. concentration. For large-scale purification, sand filters are unreliable and chlorine up to one part per million is practically inert. Bathing water is rendered safe by Liquor Cresolis Saponatus 1 in 10,000. Anglers and snipe shooters should wear waders. Treatment is by the intravenous injection of antimony tartrate. Emetine also is of service, especially for children.

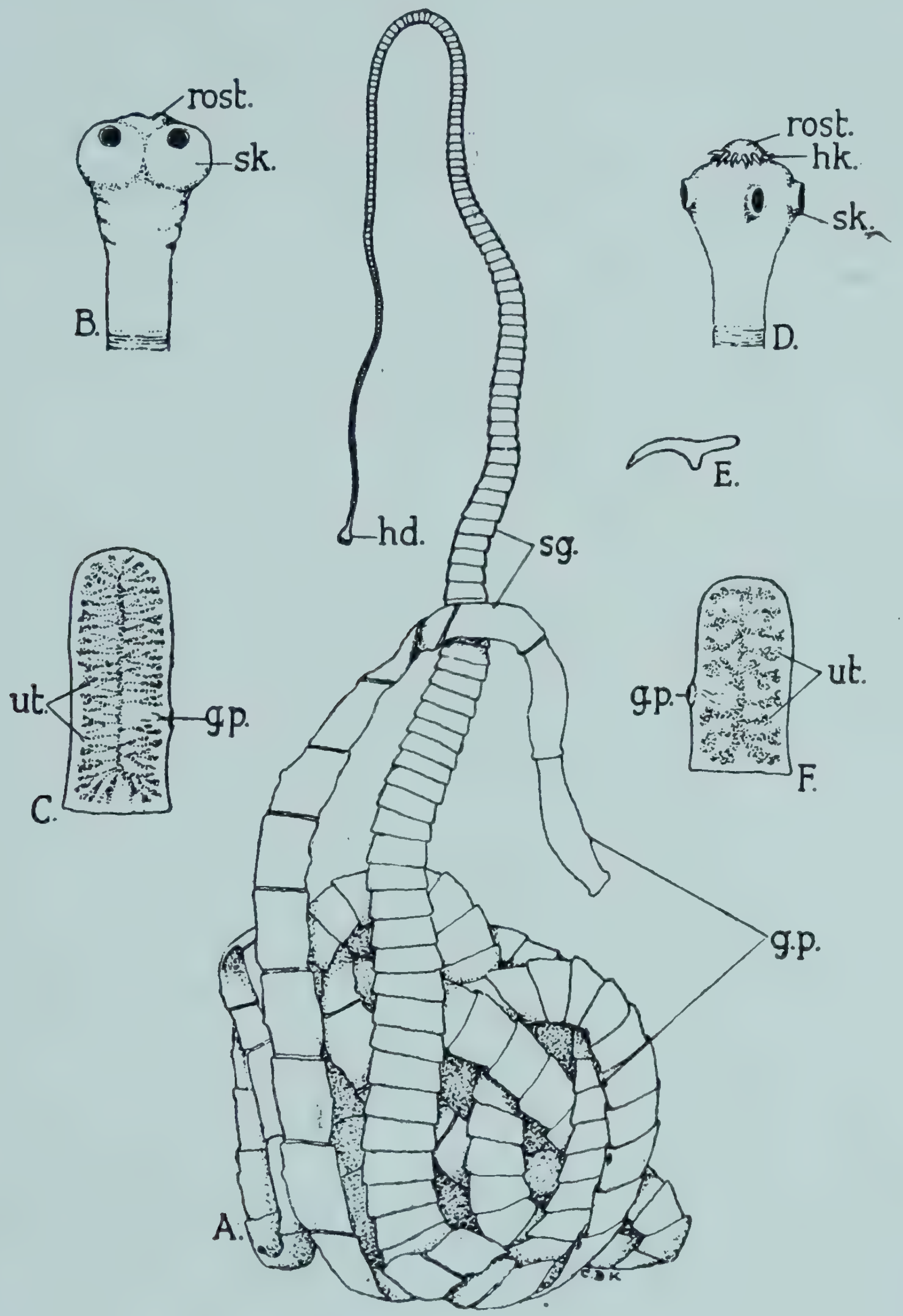


Fig. 139.—A.. B., C., Taenia saginata.
D., E., F., Taenia solium.

A. Whole worm.
B. Head of T. saginata.
C. Ripe segment showing branched uterus full of eggs.
D. Head of T. solium.
E. Hook from rostellum on a larger scale.
F. Ripe segment.
g.p. genital pore (atrium); hd. head (scolex); hk., hooks; rost., rostellum; sg., segments (proglottides); sk., one of four suckers; ut., uterus.

The *class* Cestoda, or Tapeworms, are parasitic when adult in the small intestine of vertebrates. All of medical interest have a number of segments or proglottides, which are budded off continuously throughout life, in a single row behind the neck region of the scolex or head (Fig.

139). The head bears organs of attachment in the form of suckers, and sometimes also hooks. Each segment has at least one set of reproductive organs, the oldest segments with uteri full of eggs being behind. These may become detached when mature, or earlier by accident, and the scolex is able to produce more proglottides, if necessary a complete new series. Cestodes are hermaphrodite and proterandrous. Tapeworms of medical interest belong to the Family *Taeniidae*.

Taenia saginata has some prevalence in this country. Man is the definitive host, the ox being the intermediary. The scolex exhibits four disc suckers but no hooklets. The worm is 18 to 24 feet long and its proglottides may number 2000. It may live for a period up to 15 years. The uterus of a ripe proglottis has twenty-five to thirty-five branches on either side (Fig. 139). Detached proglottides escape from the human intestine either with the faeces or by their own effort. Eggs liberated among pasture may be taken up by the ox when feeding. The hexacanth embryos or oncospheres, set free in the bovine alimentary canal, make their way to the pterygoids, tongue and pericardial fat, where they develop into the so-called cysticerci each with an invaginated scolex inside. Muscle so beset is 'measly' beef. If raw or under-cooked measly beef is consumed by man, the scolex evaginates, makes fast with its suckers to the intestinal wall of the person, and proceeds to complete its cycle by budding off proglottides. Prophylactic measures against *T. saginata* are rigorous meat inspection at slaughter, for the cysticerci are not easy to see: cold storage for 4 weeks: or freezing at 14° F. for a week. Thorough salting and very thorough cooking are of value also.

Taenia solium infestation is rare in Britain. Man is the definitive host, the pig being the intermediary. The scolex presents four disc suckers and a rostellum with two rows of hooklets. The worm is 6 to 8 feet long. It has 800 to 900 proglottides. It not uncommonly lives for 20 years. The uterus of a ripe proglottis shows seven to ten branches on either side. The ripe proglottides escape with the faeces in short chains or singly. When the eggs are taken up by the pig in feeding, the hexacanth embryos or oncospheres pass to the muscles of the shoulder-girdle, neck and tongue, or to the brain or liver. The muscles, when the cysticerci have been formed, assume a 'measly' aspect. A person who partakes of measly pork runs the risk of infestation. Thorough cooking is the only safeguard. Other intermediary hosts are sheep, deer, cats, dogs and, on occasion, man. Cysticerci in the brain or eye of man may lead to convulsions, blindness or death.

Echinococcus granulosus. Hydatid disease, which occurs in man as well as in sheep, pigs and oxen, is due to the embryonic stage of *E. granulosus.* The adult worm (Fig. 140) inhabits the small intestine of the dog, fox, wolf and jackal. *E. granulosus* is a very small cestode, its total length being $\frac{1}{6}$ inch. Its scolex shows four disc suckers and a rostellum crowned with two circles of hooklets. Of the three or four proglottides, only the last and largest is sexually mature. When the ripe proglottis is conveyed to the open in the faeces of the dog it disintegrates and liberates its eggs. When the egg is ingested by man the hexacanth embryo or oncosphere, piercing the intestinal wall, encysts as a hydatid, most frequently in the liver.

less often in the lung, kidney, brain or elsewhere. In organised communities the hydatid of man has no opportunity of further development, but the life cycle of the parasite is effectively carried on by means of the animal intermediary hosts, especially the sheep. When sheep offal containing hydatids is eaten by a dog the cyst wall is dissolved, and the freed scolices, attaching themselves to the dog's intestinal wall, complete the cycle by developing into adult worms. The human hydatid is rare in Britain. It is comparatively common in Iceland, North and South Africa, Arabia, Uruguay and the Argentine, Victoria and Tasmania. Man becomes infested by consorting with dogs. To prevent their acquiring the disease from the offal of sheep all dogs should be excluded from slaughter houses.

Of human hydatid cysts 70 per cent. are in the liver and 10 per cent. in the lung. In most cases the infestation occurs during childhood, though the slowly enlarging cyst may not attract attention before adult age. Among the symptoms are pressure effects and haemorrhage from an eroded blood vessel. Occasionally the cyst may rupture producing anaphylactic shock and wide dissemination of scolices. Pyrexia, urticaria and polymorphic eruptions may also be noted. The tissue reactions of the host include eosinophilia and specific response to the Casoni test which consists in the intradermal injection of sterile hydatid fluid. Radiographically the intact cyst throws a comparatively dense shadow. No medical treatment is of any avail. Aspiration is fraught with danger, but the hazard is reduced if enough formalin is first injected into the cyst to produce a concentration of 1 per cent. in the cystic fluid.

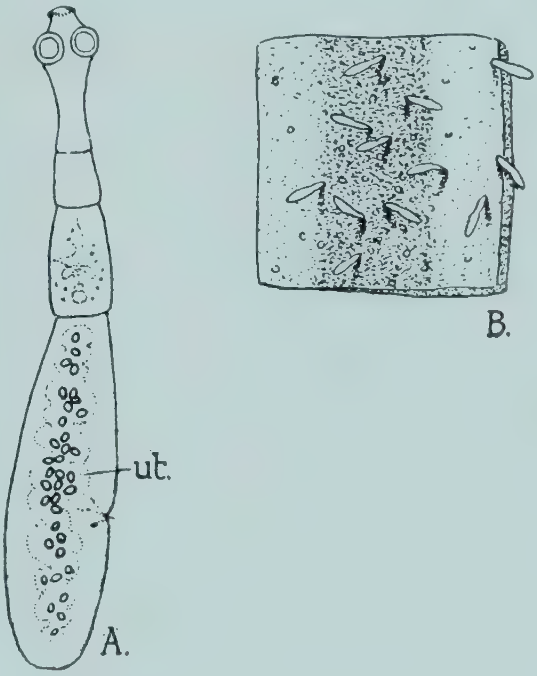


Fig. 140.—Echinococcus granulosus.

A. Adult, magnified.
B. Adult, life size, in intestine of dog.
ut. uterus.

Diphyllobothrium latum, the broad or fish tapeworm, is the largest of the man-infesting cestodes. Other definitive hosts recorded are pigs and fish-eating carnivora. The life cycle, Fig. 141, runs in succession through two intermediary hosts. The scolex has neither rostellum nor hooklets but carries two trough-like suckers or bothria from which the name is derived. The length of the worm in man may reach 30 feet. The proglottides may number 3000 to 4000. The worm has been known to live for more than 25 years. The uterus of a ripe proglottis resembles a rosette. The ripe segments lay their operculate eggs without undergoing dissolution or becoming detached. The worm is common to Russia, Sweden and Switzerland, in Turkestan and Japan and round the Central African and lesser Canadian lakes. The symptoms produced are not always severe. In some cases the blood presents the picture of pernicious anaemia. The egg, when discharged in the faeces of man, develops in water. The ciliated hexacanth embryo or oncosphere opens the operculum and swims away. If taken in as food by species of Cyclops or Diaptomus the oncosphere changes into a procercoid larva in the intestine of these crustaceans. If the crustacean is swallowed by a pike, perch or other fish the procercoid larva, freed in the fish's stomach, bores its way into the tissues, and encysts there as the plerocercoid larva, in which the bothria are apparent. If now the fish is eaten by man the plerocercoid larva, reaching his intestine, becomes the adult worm. The thorough cooking of fish is prophylactic.

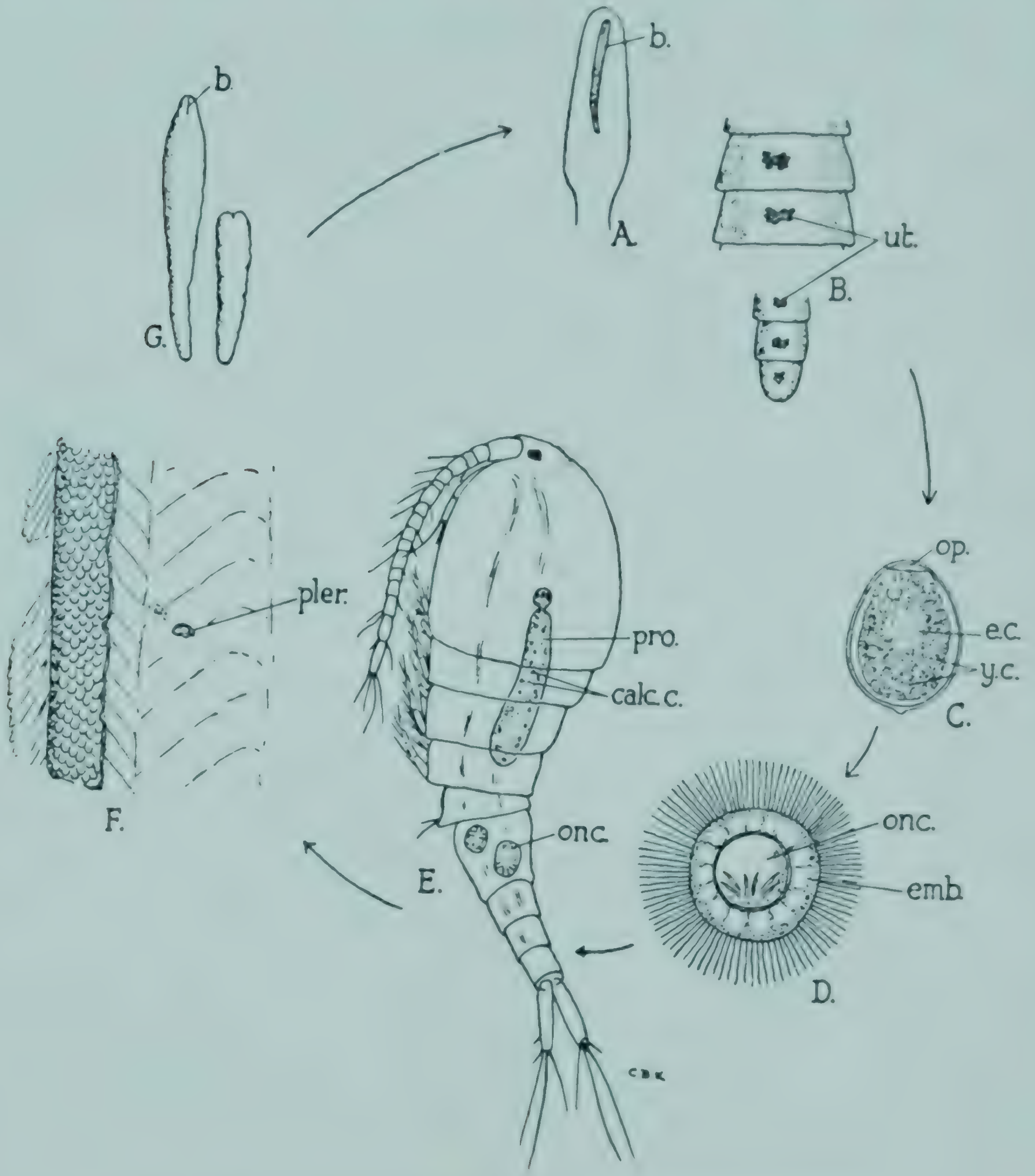


Fig. 141.—Life cycle of Diphyllobothrium latum.

A. Head of worm.
B. Ripe segments showing uterus full of eggs; below, the three terminal segments of the worm.
C. Egg.
D. Larva (coracidium) hatched from egg.
E. Cyclops containing procercoid and oncospheres.
F. Plerocercoids encysted in fish muscle.
G. Plerocercoids freed from cysts, on the left with head evaginated showing one of the two bothria.
b., bothrium; calc. c., calcareous corpuscles; e.c., egg cell; emb., ciliated embryophore; onc., oncosphere; op., operculum; p., procercoid; pler., plerocercoid; ut., uterus; y.c., yolk cells.

Certain other species of Taeniae from dogs have been reported in man. In the larval stages they may have a significance in meat inspection, as shown in Table 38.

TABLE 38.

Differentiation of Taeniae

Normal Life-history.		Reported in Man.
Tapeworm in Dog.	Larva.	
T. multiceps (= T. coenurus)	'Coenurus cerebralis' in brain of sheep and other ungulates, causing 'gid' or 'staggers.'	Larval phase, very rarely.
T. serialis . .	'Coenurus serialis' of subcutaneous connective tissue of rabbits and hares.	Larvel phase of this or very similar species.
T. pisiformis (= T. serrata)	'Cysticercus pisiformis' in peritoneum of rabbits and hares.	Both phases, but not confirmed.
T. hydatigena (= T. marginata)	'Cysticercus tenuicollis' in liver and peritoneum of sheep and other domestic animals — the 'water ball' of butchers.	Both phases, but not confirmed.

PHYLUM NEMATHELMINTHES

The worms of the *class* Nematoda are cylindrical in shape and dioecious. There is a thick cuticle, which is moulted off several times

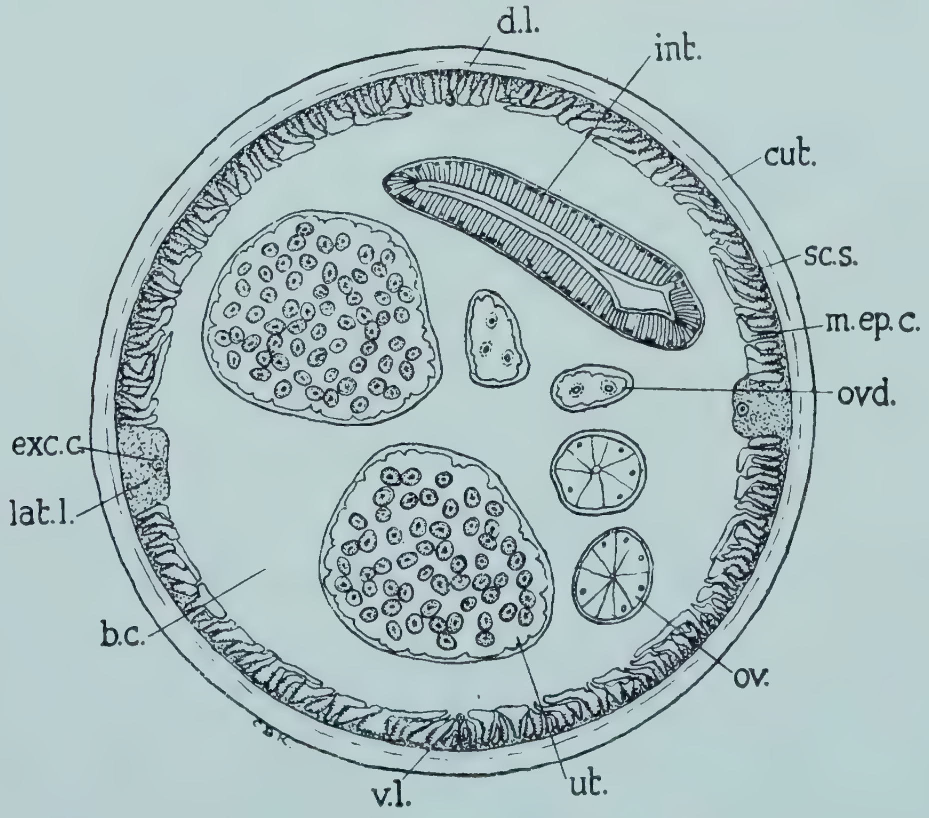


Fig. 142.—Transverse section of female *Ascaris.*

bc., body cavity; *cut.,* cuticle; *d.l.,* dorsal line; *exc.c.,* excretory canal; *int.,* intestine; *lat.l.,* lateral line; *m.ep.c.,* myoepithelial cells; *ov.,* ovary; *ovd.,* oviduct; *sc.s.,* subcuticular syncytium; *ut.,* uterus; *v.l.,* ventral line.

in the course of development. No trace of segmentation, and no appendages are present. Many look like thick threads, whence their popular name of 'threadworms.' Within the cuticle is a syncytial protoplasmic layer, then a ring of myoepithelial cells (Fig. 142), enclosing a conspicuous body cavity in which lie the alimentary canal and reproductive organs. Nematodes are bisexual, the females being larger than the males.

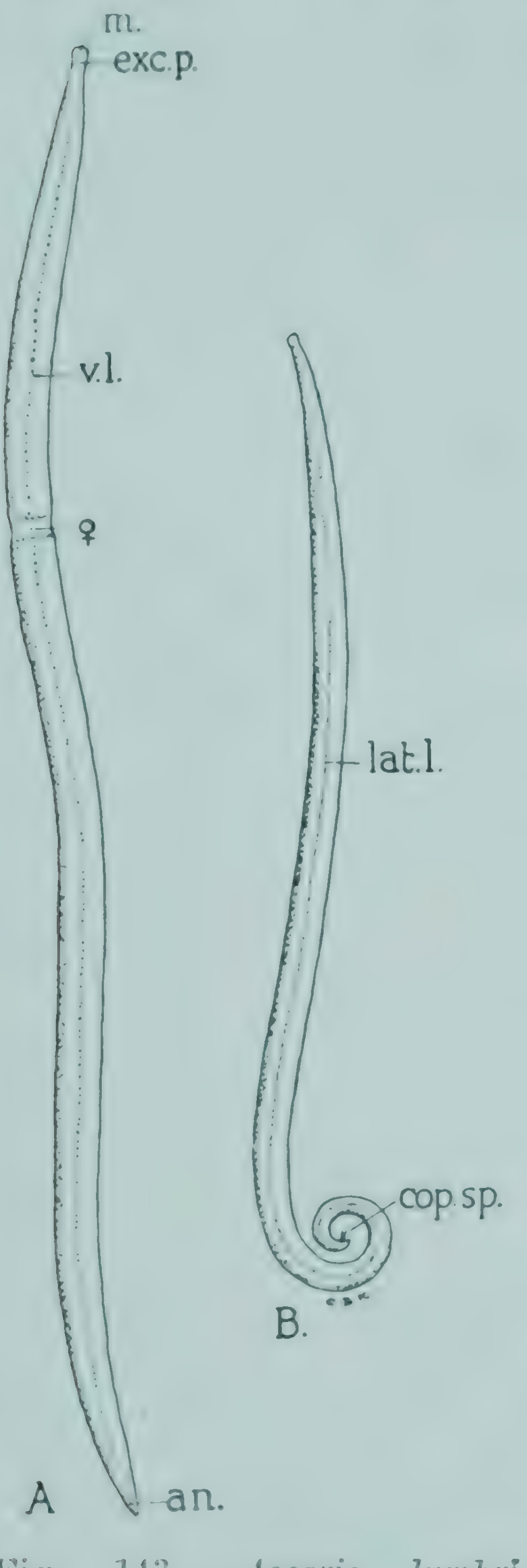


Fig. 143.—*Ascaris lumbricoides.*

A (after Graham Kerr). Female worm in ventral view.
B. Male worm in lateral view.

an., anus; *cop. sp.*, copulatory spicules protruding from cloaca; *exc. p.*: excretory pore; *lat.l.*, lateral line; *m.*, mouth; *v.l.*, ventral line; ♀, genital pore.

Ascaris lumbricoides, Fig. 143, inhabits the small intestine of man. The male is 5 to 9 inches long: the female 8 to 12 inches or more. The tail of the female is straight, while that of the male is incurved. The parasite is conveyed from person to person without the aid of an intermediary host. The very characteristic eggs, Fig. 144, when expelled from the intestine of man undergo development in moist soil, the embryo forming within the shell. If they are now swallowed by another human host along with, say, polluted water or vegetables, the embryos hatch out in the intestine, pierce the intestinal wall and are carried in the blood stream first to the liver and next to the lung. Breaking through the pulmonary alveoli, they move up the bronchi, reach the larynx and then, being swallowed, return to the intestine in which they may attain sexual maturity a month or two after hatching. The number of worms in a case is usually small, but may on occasion run up to several hundreds. Infestation, which is attended by eosinophilia, may exist without overt symptoms, or there may be cutaneous, gastric and nervous derangements. The embryos may set up pneumonia, and migrant adults may cause suffocation, jaundice or appendicitis according to the organ invaded. The appropriate anthelmintic is santonin, given at night. The dose for a child should be one-sixth of a grain for every year of age and it should be repeated on each of three successive nights, followed by a vermifuge dose of calomel. An insanitary environment favours transmission, especially where human excreta are used as manure for vegetable crops.

The risk from contaminated soil is persistent, as the embryo may remain for years alive within the egg. Ascariasis is world wide in man. It occurs also in apes, sheep, cattle and dogs. *A. suilla,* which infests swine, is closely related to *A. lumbricoides,* but the weight of evidence is against complete identity of species. The larger *A. megalocephala* occurs in horses.

Enterobius vermicularis, formerly Oxyuris, is the thread worm of the intestine of man. The male, which is $\frac{1}{8}$ to $\frac{1}{5}$ inch long, is curved at its caudal end: in the female, which is $\frac{1}{3}$ to $\frac{1}{2}$ inch long, the tail is straight and pointed. The female lays her eggs near the anus or on the skin outside. The itching produced leads to scratching, as a result of which eggs are conveyed to the mouth and swallowed, to hatch out later in the intestine and swell the numbers of the invading parasite. Inunction of the anus with mercurial ointment acts in restraint of this auto-infestation: so also does scrupulous cleanliness of the hands and person generally. Quassia enemata are vermicidal. Enterobius infests children in all parts of the world.

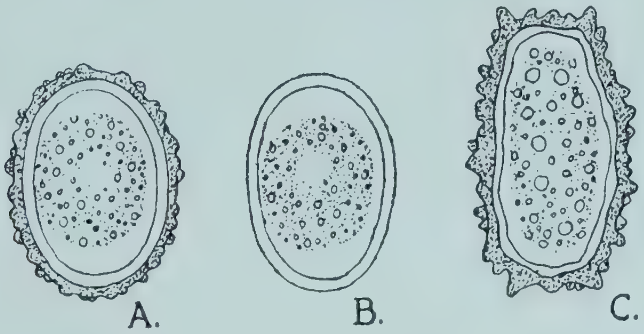
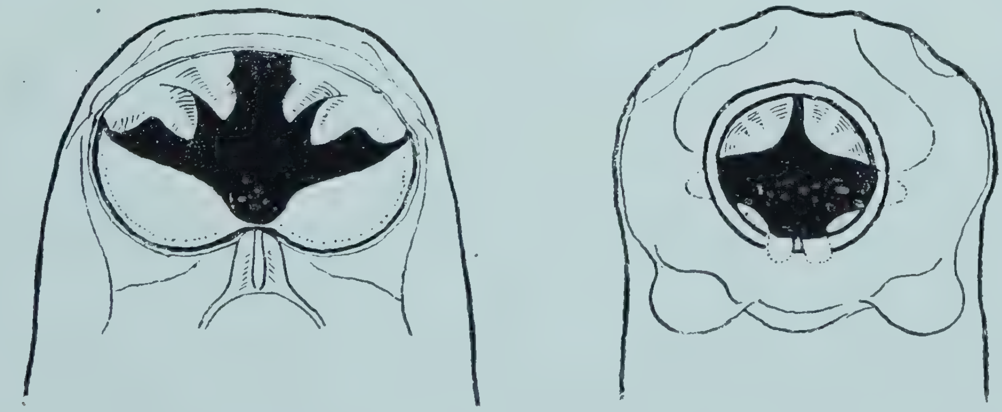


Fig. 144.—*Ascaris lumbricoides eggs.*

A. Normal egg.
B. Egg with imperfect shell.
C. Unfertilised egg.



Ankylostoma. Necator.

Fig. 145.—Hook Worm Mouths.

Ankylostoma duodenale, the hook worm, is so named from its two pairs of strong hooked teeth (Fig. 145). The male is 8 to 11 mm. in length, the female 12 to 15 mm. The worm inhabits the upper portion of the small intestine of man. The eggs, when passed out in the faeces, usually contain a four-celled embryo. Under humid conditions and at temperatures round 85° F. the larva quickly hatches out, sometimes in 8 hours. It moults twice in the open, becoming first filariform and then encapsuled. In the encapsuled stage, which may last for weeks or months, it is capable of infecting a new host. It secures entrance mostly through the skin of the feet and legs by way of the sweat glands an hair follicles. It is carried in the blood stream through the right heart to the pulmonary capillaries. It breaks through into the alveoli, passe

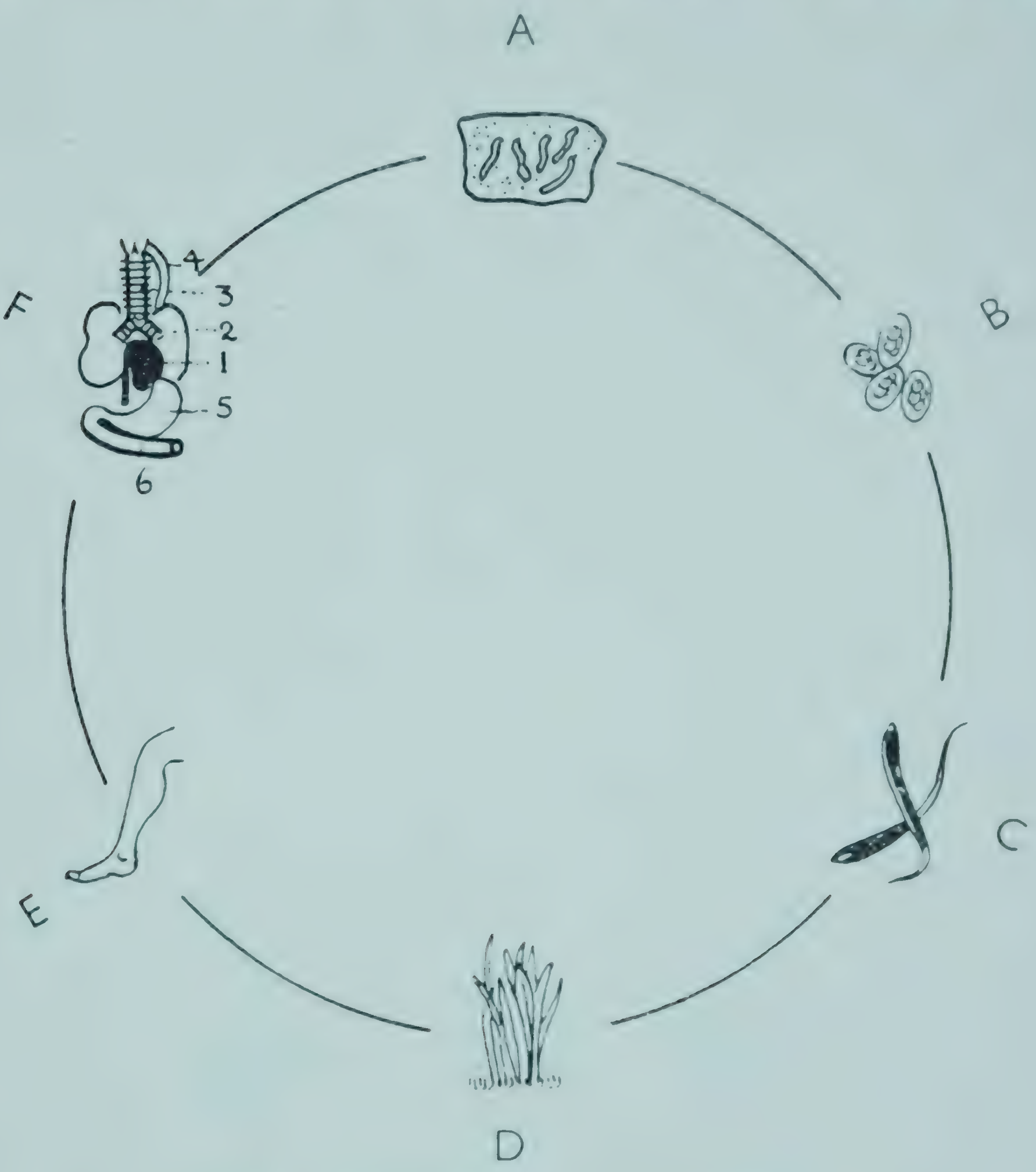


Fig. 146.—Life cycle of A. duodenale.

A. Adult worms in duodenum. B. Fertile eggs leaving body.
C. Filariform larvae hatched. D. Encapsuled larvae on grass.
E. Usual site of entry of larvae F. Route of larval invasion:
1. blood; 2. lung; 3. bronchus; 4. oesophagus; 5. stomach;
6. duodenum.

up the bronchi to the oesophagus and so to the small intestine (Fig. 146 Here it moults twice more. After the fourth and final moult it i sexually mature. Eggs may appear in the faeces 6 weeks from the dat of percutaneous entry. *A. duodenale* is found in the tropical and sub tropical regions of every continent which provide the degree of warmt and moisture essential to its development. In colder countries it ha occurred in underground workings, such as the Simplon tunnel and th Dolcoath mine in Cornwall. It is the parasite of hook worm disease,[1] known also as Egyptian chlorosis and miners' anaemia.

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[1] Page 460.

Necator americanus, another hook worm species, is shorter than *A. duodenale.* Its mouth carries cutting blades instead of hooked teeth. It is the causative agent of hook worm disease not in America only but also widely in Africa, Asia and Polynesia. Both Ankylostoma and Necator attack pigs, cats and dogs as well as man. The related *A. brasiliense,* a common parasite in cats and dogs, has on occasion been reported in man. The larval stage may cause the ‘creeping eruption.’

Wuchereria bancrofti, otherwise *Filaria nocturna,* is an inhabitant of tropical and sub-tropical countries. The filariasis which it occasions may in some cases be sub-clinical. In others the evidences of lymphatic occlusion may range from lymphangitis to lymphatic varix, lymph scrotum, chyluria and elephantiasis. The male Wuchereria is under 2 inches long: the female about 3 inches. They live and pair in the lymphatics, especially about the inguinal glands. Their progeny, the sheathed microfilariae, (Fig. 147), migrate into the blood system where they spend the day in the lung vessels and great arteries, and throng the peripheral circulation at night. Sucked up thence in the blood drawn by a night-flying culicine mosquito, most often *C. fatigans,* they slough their sheaths and, after metamorphoses, come to rest in the labium of the insect. While the infested mosquito is sucking blood they break out of the labium and enter the skin of their new host, not through the puncture made by the insect but by ways of their own. They then pass to his lymphatics where they reach maturity within 12 months. The prophylaxis of filariasis bancrofti lies in mosquito control.

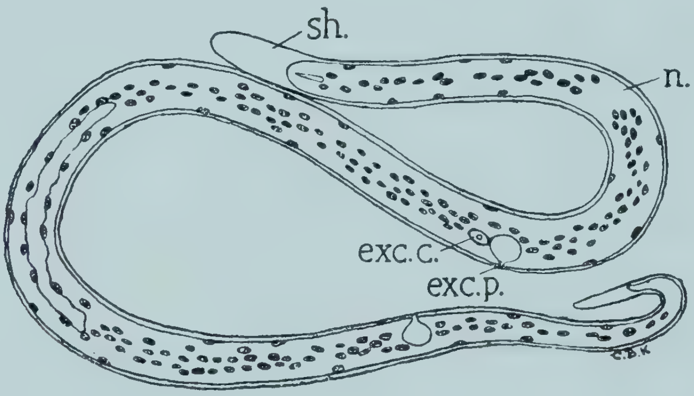


Fig. 147.—Microfilaria of *Wuchereria bancrofti.*

exc.c., ‘excretory cell’; *exc.* p., ‘excretory pore’; *n.*, position of nerve ring; *sh.*, sheath, usually held to be the greatly stretched egg shell.

Oncocerca volvulus is a common invader of native populations in areas of West Africa. As many as 50 per cent. of the people in a locality may be infested. The adult worms live in the subcutaneous connective tissue, in fibrous tumours as large or larger than a walnut. These ‘worm nodules’ contain several worms coiled up together, and may be very painful. The cuticle in worms of both sexes is decorated with transverse thickenings. The male is 20 to 40 mm. long, and the female 50 to 70 mm. The microfilariae, 300 μ long and sheathless wander through the skin, being rarely found in the blood. The vector is *Simulium damnosum.*

Other species are known in domestic animals, where the nodules m
result in depreciation of the meat. For example in Australia *O. gibso*
of cattle is said to be responsible for a loss on damaged meat
£1,000,000 per annum.

Loa loa, otherwise *Filaria diurna*, causes the transient oedema kno
as Calabar swelling in West Africa and Uganda. It may on occasi
be seen moving under the skin or passing across the eye-ball. I
microfilariae people the surface vessels by day and disappear at nig
The day-biting mangrove flies of the genus Chrysops, 3·5 per ce
of which in Calabar are naturally infected, are the insect vecto
L. loa takes several years to mature in Man, and is known to li
as long as fifteen years.

Dracunculus medinensis, the Guinea worm, has a wide but locali
distribution in the tropics and sub-tropics. It is found in t
Northern tropical and sub-tropical regions of Africa and As
in places where the water supply is scanty and drawn from ne
the surface. It was established in South America by import
slaves in Brazil and Guiana. Where it occurs it may be very comm
but very local. One tribe on the Ivory Coast is named after t
lameness caused by the Guinea worms so constantly in their le
while a neighbouring tribe is quite free from infection. The wo
lives in the connective tissue of man. Infestation, which is call
Dracontiasis, is the rule in some districts. Of the male worm litt
is known: the female is up to a yard long and about one-twenti
of an inch in diameter Fig. 148. After mating, the fertilised fema

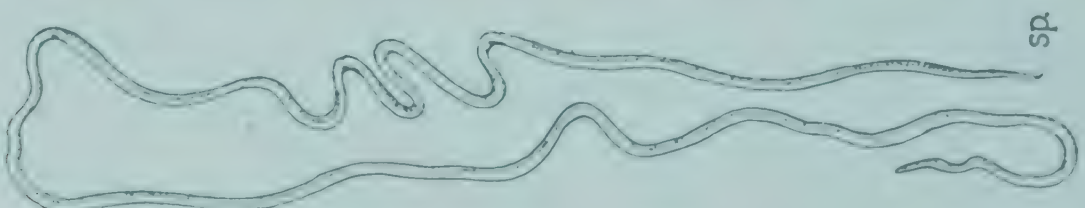


Fig. 148.—Female Guinea worm. Half life size.
sp., spine at posterior end of worm.

bores her way to the surface of some dependent part of the body, m
frequently the foot or ankle, and perforates the skin. The nati
perform extraction of the worm by winding it round a match sti
day by day, a small portion at a time (Fig. 149). At the touch of c
water a protrusion of her uterus presents through the perforation. T
tense sac immediately ruptures, freeing a swarm of embryos in
water. This process is repeated, always at the touch of water, till
uterus is clear. The perforation is slow to heal and may becom
painful chronic ulcer. The embryos, if now swallowed by a Cycl
undergo metamorphoses in the crustacean and, when in its turn
infested cyclops is swallowed by man while drinking water, they m
their way into the connective tissue of their new definitive host. I
protective against dracontiasis to use running water or deep wells
drinking, and to exclude infested persons from access to water suppl
Cyclops in water may be disposed of by putting the water throug

strainer, or killed by blowing steam into water holes or by dosing the water with potash in 0·7 per cent. concentration.

Trichinella spiralis, known also as *Trichina spiralis,* is the causative agent of trichiniasis or trichinosis. This disease principally affects man, the pig, and the rat, the last of which may be the reservoir host. The condition has been observed also in the cat, dog, rabbit, badger, fox and brown and polar bears. Human infestation, though unusual in Great Britain, is widely distributed in India, China, Algeria, East Africa and Australia. It is prevalent in Germany and North America. The male adult Trichinella is 1·5 mm. long and the female 3 to 4 mm. Their habitat is the small intestine. The fertilised female settles in the intestinal wall, whence her brood of embryos passes into the blood stream, and is conveyed to the tongue, diaphragm, intercostal or other striated muscle, where the embryos encyst (Fig. 150). In the cysts, which are 0·5 mm. long, the coiled embryos have been found alive up to 11 years in the pig and 31 years in man. In human infestations the life history of the worm terminates at this stage, but in the case of the pig, if the raw or undercooked trichinosed flesh is eaten by man, the contained embryos are set free to develop in his small intestine and begin the cycle anew.

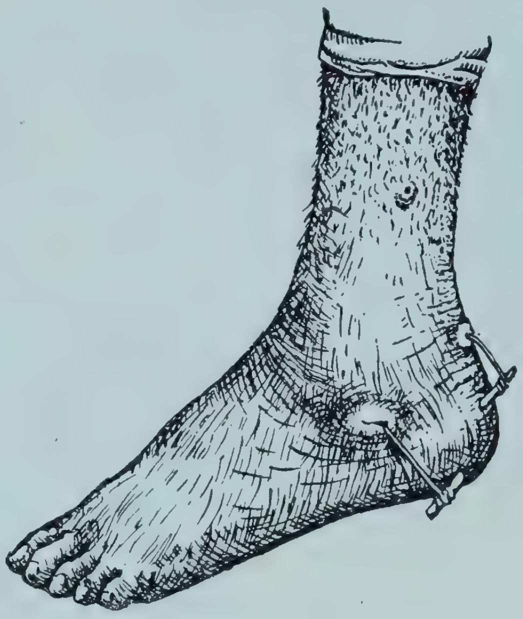


Fig. 149.—Native method of extracting Guinea Worm.

Trichiniasis in man tends as a rule to be a serious disease. Eosinophilia is usually marked and the mature worms, when numerous, acutely inflame the intestine, and cause dangerous or fatal haemorrhages. The embryos, as they pervade the body, cause the patient intense suffering on which delirium supervenes, and their encystment is attended by oedema and toxic cachexia which may result in death. In severe cases the number of embryos present may total fifty millions. The diagnosis is confirmed by the biopsy of a muscle, or, it is claimed, by intradermal and precipitin reactions to antigen contained in suspensions of pulverised embryos. The mainstay of prophylaxis is the thorough cooking of pork, up to 137° F., as evidenced by the blanching of the piece in all its parts. Ransom recommends refrigeration at 5° F. for 20 days. Intradermal and blood tests applied to the pigs before slaughter may give a timely warning. With a view to preventing the infestation of pork, pigs should not be fed on uncooked pig offal, and all abattoirs should be made rat-proof and kept rat-free.

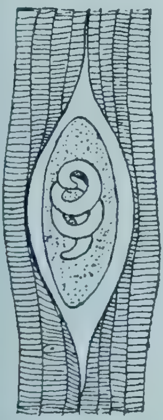


Fig. 150.—Trichinella Encysted.

PHYLUM ARTHROPODA

The Arthropods have segmented bodies and legs with joints. Their

cuticle is tough or rigid for protection and support. Their classes
most medical interest are the Insecta and Arachnida.

CLASS INSECTA

The typical insect displays a head, thorax and abdomen. The he
carries two compound eyes, together with simple eyes or *ocelli*, also
pair of antennae and sundry mouth-parts. The thorax is in thr
segments, each of which supports a pair of legs. Wings when prese
are attached to the second and third segments. The thorax presents tw
pairs of spiracles for breathing. The abdomen, which has furth
spiracles, consists of eleven segments. Many insects undergo a comple
metamorphosis, the successive forms being the egg, larva, pupa an
imago.

Table 39 shows the Insect Orders which include forms of medical
hygienic interest.

TABLE 39.

CLASS INSECTA

ORDERS OF MEDICAL INTEREST

Orders.		
Thysanura .	Bristle-tails	Lepisma, Thermobia.
Collembola .	Spring-tails	Achorutes, Podura, Isotoma.
Orders.		
Orthoptera .	Locusts, Cockroaches	Blatta, Blattella, Periplaneta.
Anoplura .	Sucking Lice	Pediculus, Phthirus.
Rhynchota .	True Bugs	Cimex, Conorhinus (Triatoma).
Orders.		
Lepidoptera .	Butterflies: Moths	Household and warehouse moth
Coleoptera .	Beetles	Affecting stored cereals, skin furniture and woodwork. Als blistering beetles.
Diptera . .	Two-winged flies	Tabulated below.
Siphonaptera .	Fleas	Pulex, Xenopsylla, Cerato phyllus, Dermatophilus.
Hymenoptera .	Wasps, Bees, Ants	Vespa, Mutilla, Monomorium.

Order THYSANURA

The Thysanura or Bristle-tails are primitive and wingless. T
common household kinds are *Lepisma*, the 'silver fish' (Fig. 151) and
dark-coloured *Thermobia*, which is the 'fire-brat' of the fireplace and
'baker's brat' of the bakehouse. Both are carrot-shaped and run fa
they nibble and may be very destructive. *Lepisma* is about one-th
of an inch long; its appearance reminds one of a sardine. It may
found in the larder, in cupboards, and amongst clothing in draw
It eats almost anything of a vegetable nature, whether food-stuff
fabric. *Thermobia* is about half an inch long and banded with grey

black scales which give it a mottled appearance. Useful checks for these insects are pyrethrum and sodium fluoride.

Order COLLEMBOLA

Of the Collembola or Spring-tails several kinds, about 1 or 2 mm. long, abound in damp places almost everywhere out of doors. They usually have short antennae and are without cerci, but most of them have a terminal forked process, carried bent in under the abdomen, with which they suddenly spring. Some frequent the surface of water. *Podura aquatica* may be seen in crowds, 'like floating iron-filings,' on the surface of stagnant ponds. The small white *Isotoma fimetaria* is common both on the ground and on water, and often appears in cisterns. *Achorutes purpurescens* and *A. viaticus* occur in sewage works: they feed on organic matter and thus aid the passage of humus through the percolating filters.

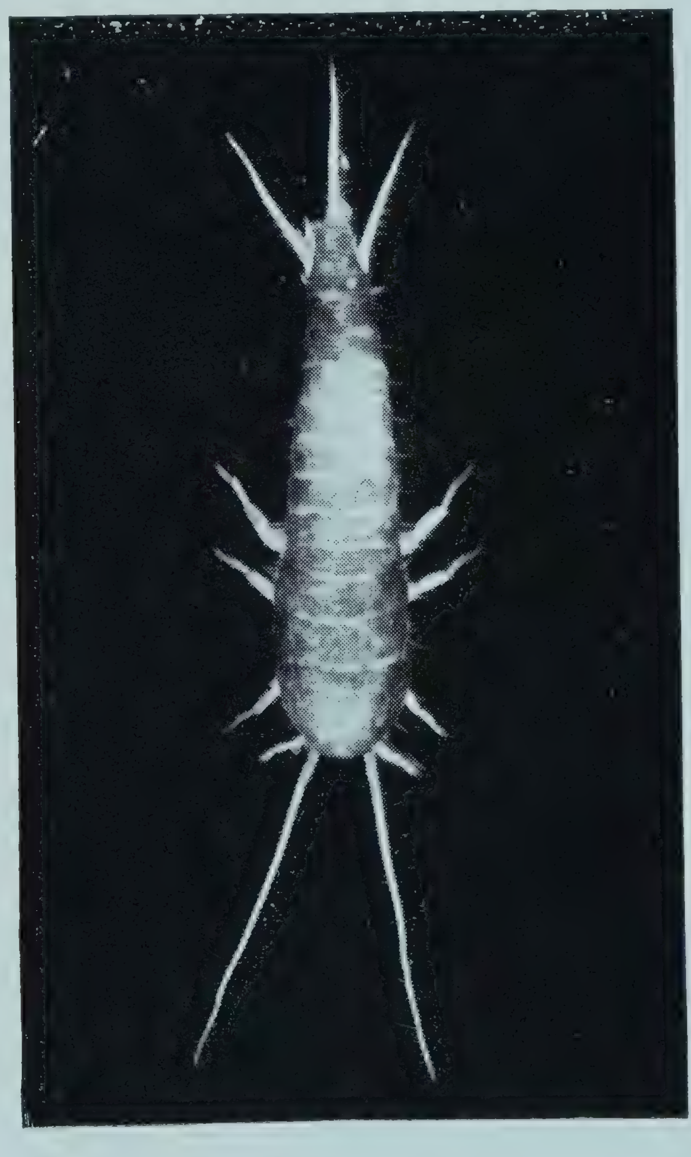


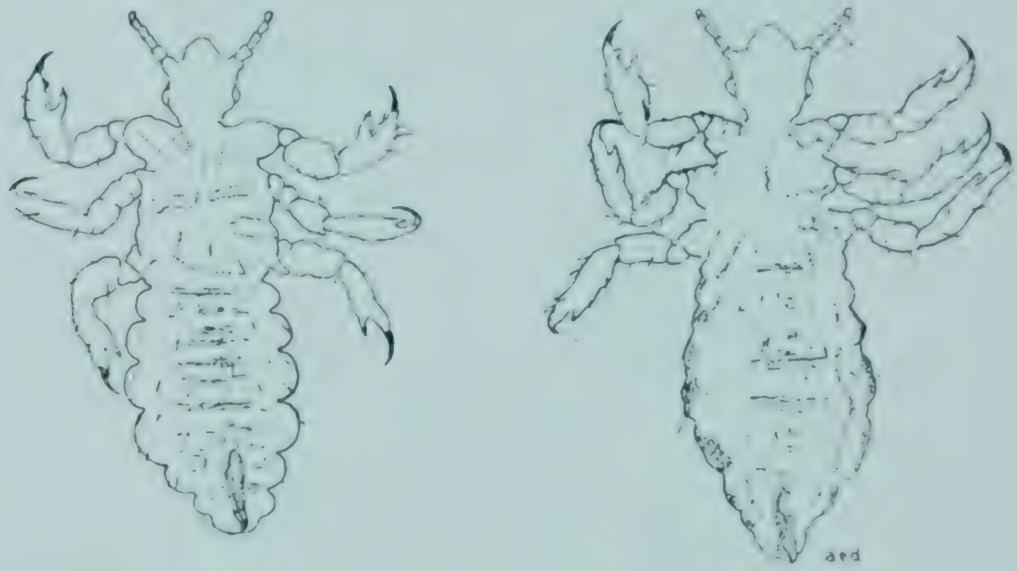
Fig. 151.—Lepisma saccharina.

Order ORTHOPTERA

Blatta orientalis, the Common Cockroach or 'black beetle' is dark-coloured and 1 inch long. Another common domestic species is the small *Blattella germanica*. It is about ½ inch long and yellowish-brown with two dark longitudinal streaks on the pronotum. The tegmina an wings reach beyond the end of the body in both sexes.

Periplaneta americana, the American or Brown Ship-Cockroach, i a larger species, about 1½ inches in length: it is chestnut brown and the pronotum is mottled with lighter brown within the margin. Both sexes have well-developed tegmina and wings. It is seen most frequently on board ship, and it occurs in dock warehouses and factories, but only locally in dwelling houses. It has been supplanted in many places by *P. australasiae*, the Australian Cockroach, very similar but smaller and readily recognised by the narrow elongated yellow mark on the shoulder of each tegmen.

Cockroaches will eat almost anything. They are spoilers of food stores and clothing: it is not the quantity they consume, but everything they touch is defiled with their peculiar offensive smell, which arises from the oily secretion of a pair of glands in the soft skin between the nota of the fifth and sixth abdominal segments.



P. capitis. **P. corporis.**

Fig. 152.—Pediculi ♂.
***aed.* genitalia.**

Cockroaches lay a number of eggs at a time packed side by side in two rows in an egg capsule. This capsule is formed within the genital pouch from a glandular secretion which hardens and turns brown on exposure to air. The egg-case of *Blatta* is somewhat cylindrical and about 12 mm. long, with the upper edge serrated: it usually contains 16 eggs.

Poisons for cockroaches are sodium fluoride, phosphorus or plaster of Paris, made up in each case with flour. Anti-cockroach powder consists of 3 parts sodium fluoride and one part pyrethrum dust. The powder should be scattered about the haunts of the insects. Experiments are now proceeding with 'Gammexane'[1] developed by Imperial Chemical Industries and claimed to be effective against Blatta and its congeners. D.D.T. (Geigy)[1] as a 10 per cent. spray in kerosene, and the associated Proprietary 'Neocid' are also effective. Treatment of infested premises should be repeated fortnightly until no more cockroaches appear. Foodstuffs should be covered during the dusting process. Fumigation with

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[1] Page 573.

SO_2 or HCN may be employed, the latter under strict precautions owing to its attendant dangers. The dose of HCN required to kill both the insects and their eggs is 4 ounces per 1000 cubic feet and 2 hours' exposure. Obstructive wood-work in buildings should be stripped off and crevices in walls and flooring filled up.

Order ANOPLURA

This order of small, flattened, wingless ectoparasites includes the sub-orders *Siphunculata* (Sucking Lice) and *Mallophaga* (Biting Lice). The Mallophaga are distinguished by the large head and more distinct body segmentation: they infest birds and domesticated animals.

Pediculus corporis is the body louse of man. Except when feeding, it lies hidden in the seams and folds of the clothing, to which the female attaches her eggs or 'nits.' Its elliptical abdomen (Fig. 152) is neither deeply segmented nor markedly scalloped at the edges. The male is 3 mm. long, the female 3·3 mm. The female during her life of one month lays up to 300 eggs. In the seams of clothing the eggs may remain alive for 30 days. *P. corporis* is the natural vector of typhus fever, trench fever and the European, North African and Indian types of relapsing fever.

The modern method of body louse disinfestation employs Dichlor-diphenyl-trichlorethane 'D.D.T./Geigy.' For the suppression of body lice, 10 per cent. D.D.T. in kaolin should be insufflated between the skin and the inner garments by means of a Dobbin or Hudson 'blower.' In emergency, a horticultural weed duster, with sawn-off nozzle, will serve. Approximately 2 ounces of the powder are required for each person. Special attention should be devoted in treatment to neck and waist bands of garments, and to the axillary and crutch regions. When a blower is not available, the clothing should be removed and the individual garments dusted both inside and out with the powder. D.D.T. in clothing retains its lethal properties for a period up to 4 weeks. Allowing for reasonable co-operation on part of the person under treatment, a team of two operatives can deal with 20 subjects per hour. This fact renders the method suitable for mass treatment of populations, as at a time of typhus prevalence. When D.D.T. is unobtainable, or when the subject is allergic, an alternative method is to apply an emulsion of paraffin 30 per cent. and olive oil 70 per cent., smearing on thickly and rubbing in well especially on hairy parts. Follow with a hot bath and clean clothing. In severe cases remove all body hair by shaving with a safety razor. Or alternatively, after a hot bath, rub 10 per cent. acetic acid into the body hair and comb out with a fine tooth comb. Regular bathing and change of clothing are prophylactic.

Clothing. Boil linen and cotton underwear. Place woollens in lysol 2 per cent. solution, raise gradually to 140° F. and wash. Iron all suitings with a hot iron, especially under the free edges of seams. At cleansing stations verminous clothing should be passed through the steam disinfector, or a special hot-air delouser may be employed. The Dodwell Dunning electrical heater, with the air in the chamber slightly above atmospheric pressure and temperature at 200° F., destroys lice and nits on clothing in 15 minutes. Articles which cannot be heated may b disinfested by soaking in 5 per cent. cresylic acid for 20 minutes.

Premises. A thorough scrubbing usually suffices to purify rooms vacated by verminous persons. In special cases SO_2 gas may be employed, 3 lbs of sulphur being burned per 1000 cubic feet of space and 6 hours' exposure given. Medical practitioners and other persons exposed to risk of infestation may repel lice by dusting their clothing inside with 10 per cent. D.D.T. powder.

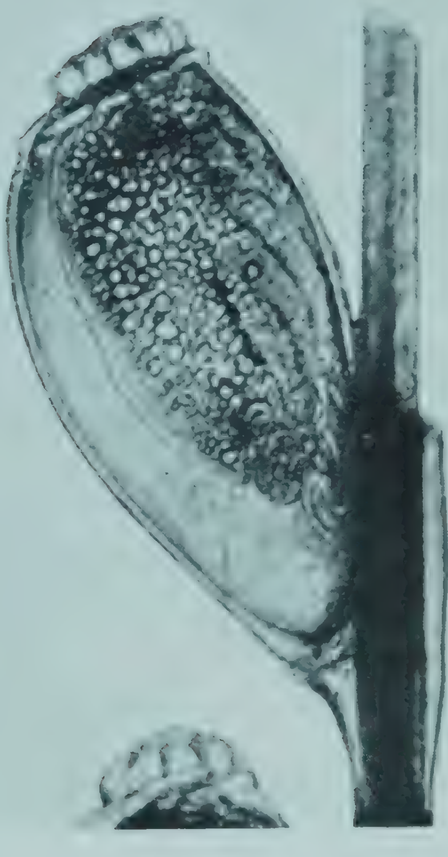

Fig. 153.—Egg (nit) of *P. capitis* on hair.

Pediculus capitis, the head-louse of man, is usually regarded as a variant of *P. corporis,* not a separate species. It infests the hair of the scalp, to which the female attaches her eggs (Fig. 153). It may occur also in the pubic hair or eyebrows. Its obscurely triangular abdomen (Fig. 152) is deeply segmented and markedly scalloped. The male is 1·6 mm. long, the female 2·7 mm. The head louse is capable of transmitting the same infections as the body louse.

The approved remedies for pediculosis of the scalp are lethane '384 special' in white oil, and derris cream. 'Lethane special' consists of a mixture of N-butyl carbitol thiocyanate, β-thiocyanoethyl laurate and refined paraffin. The preparation should be used in 25 per cent. strength. The derris compound recommended by Buxton contains derris extract in castor oil emulsified with lanette wax to the consistency of a cream.

The patient's hair should be parted in the middle and the lethane or derris cream applied direct to the scalp at eight separate points. The remedy should then be distributed by massage with the fingers, not by combing. The patient is instructed to wait for ten days and then wash the scalp with a coal tar or similar shampoo.

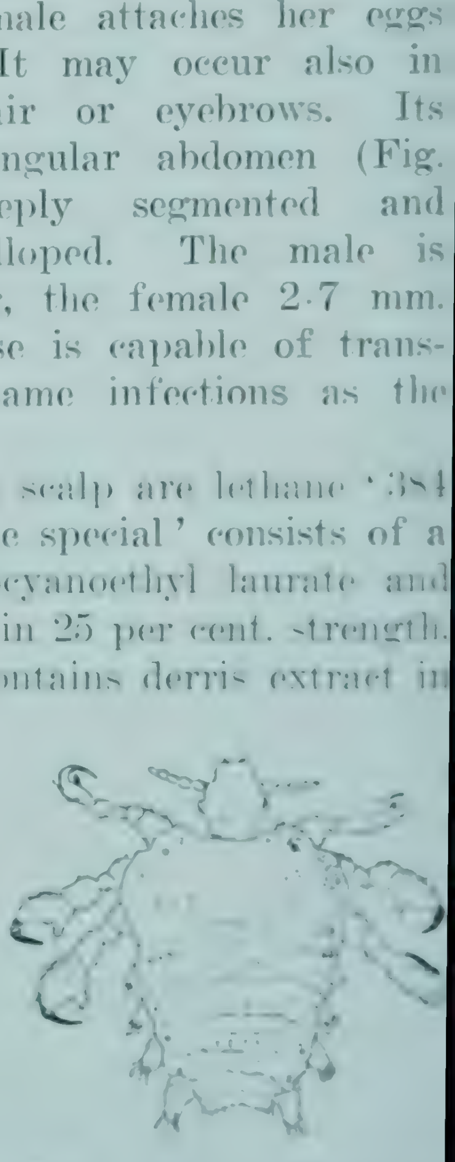

Fig. 154. — Phthirus pubis ♀.

Good results have recently been reported from the use of 2 per cent. D.D.T. emulsion, but this method is still on trial.

Phthirus pubis, the crab louse of man, inhabits the hair of the pubi and perineum, whence it may ascend to that of the chest, axillae an face, including the eyebrows and eyelashes. The male is 1 mm. lon the female 1·5 mm. The insects excite a local eruption often attended by itching. They are difficult to see, being rather transparent, but a rusty staining at the roots of hairs may suggest their presence. *P. pubis* is not accused of transmitting any specific infection.

To destroy the crab louse the pubic region should be lathered well with tar soap and shaved close. The shaved surface should then be anointed with Unguentum Hydrargyri Ammoniati dil. Two applications of this treatment usually suffice. The intercrural area and the intergluteal fold should specially be dealt with. Dusting with 10 per cent. D.D.T. in kaolin is also effective. In cases of secondary bacterial infection, preliminary lavage of the parts with a 1/2,000 solution of perchloride of mercury is recommended. For infestation of the hair of the chest or axilla the part is first washed with dilute acetic acid, then treated with an emulsion of paraffin and olive oil each 50 per cent., and finally shampooed with a pine tar soap. In the case of the eyebrows it usually suffices to pick off the nits one by one with fine forceps. Derris root with lethane is potent against both *phthirus* and *pediculus*. Lethane should not be employed for domestic pets.

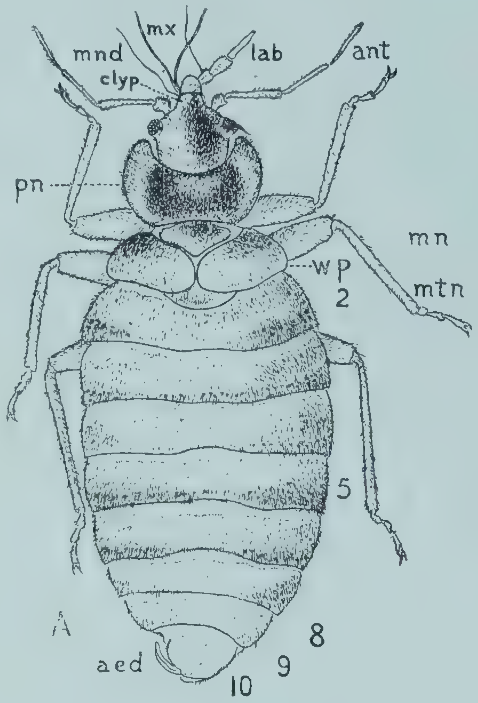

Fig. 155.—Cimex lectularius ♂. Dorsal aspect.

aed., genitalia; ant., antenna; clyp., clypeus; lab., labium; mn., mesonotum; mnd., mandible; mtn., metanotum; mx., first maxilla; pn., pronotum; w.p., wing pad (hemielytron); 2-10, abdominal segments.

Order RHYNCHOTA

The Order Rhynchota or Hemiptera includes the bugs and various other forms, such as the cicadas, plant-hoppers, green-fly or aphides and scale-insects. In the true bugs the front or upper wings are hemielytra, *i.e.*, the basal portion is thickened and leathery and the other portion is membranous.

Most bugs are sap-suckers, but some of the predaceous species are active blood-suckers of birds and mammals including Man.

Cimex lectularius (Fig. 155), the bed bug of Europe, is a flat insect up to $\frac{1}{4}$ inch in length. Its strong beak inflicts a painful wound. The mark of the bite is a red blotch showing small papules and often swelling or wheals. Though the bed bug sucks the blood of man it does not normally convey disease. Bugs inhabit cracks in walls and crevices in wood-work and furniture. They are found about the joints of iron-bedsteads, or behind picture frames and skirting boards. They infest ships also. *Cimex rotundatus* is the large bed bug of the tropics. *Conorhinus megistus* (Fig. 156), another bug, frequents clay-walled dwellings in Brazil, where it conveys to man Chagas's disease, the South American trypanosomiasis.

To exterminate bugs in houses, obstructive wood-work and wall-paper should be stripped, and paraffin or turpentine or scalding water or saturated solution of $HgCl_2$ applied to surfaces and injected into recesses. Flaming with a painter's blow lamp is often effective. Sulphur dioxide fumigation may be employed, 3 lbs. of sulphur being burned per 1000 cubic feet of space in the room and 6 hours' exposure given. Hydrocyanic acid gas is the most potent agent, but owing to its attendant dangers it is permissible only for ships or unoccupied or completely vacated land premises. The strictest precautions must be taken, respirators being worn by those in charge. A concentration of 2 per cent. of HCN should be maintained for 6 hours. Sealed fumigation vans have been devised for the purpose of treating with HCN *en route* family furniture which is being transported from a bug-infested house to one presumably free. Unupholstered furniture may often be disinfested by vigorous scrubbing with soap and hot water, and upholstered furniture by spraying with an extract of pyrethrum in paraffin containing 4 ounces of methyl salicylate to the gallon. The vapour of heavy coal-tar naphtha combined with cresylic acid has been recommended. It is claimed to be fatal to bugs in moderate concentrations while at the same time non-toxic to man. Spraying with 6 per cent. lethane '384 special' in kerosene lately had given good effects in air raid shelters. Five per cent. D.D.T. in kerosene has given satisfactory results in dwellings. The D.D.T. may be dissolved directly, allowing a few days for complete solution, or a 25 per cent. D.D.T. concentrate in, say, xylene may be employed to make the kerosene dilution. It has recently been claimed that D.D.T. emulsion containing β butoxy-β-thiocyano-diethyl ether, as in the proprietary 'Lethol P,' is markedly ovicidal and retains its properties for several months on fabrics and furniture. Solid D.D.T. should not be handled without gloves. 'Gammexane'[1] also gives good results.

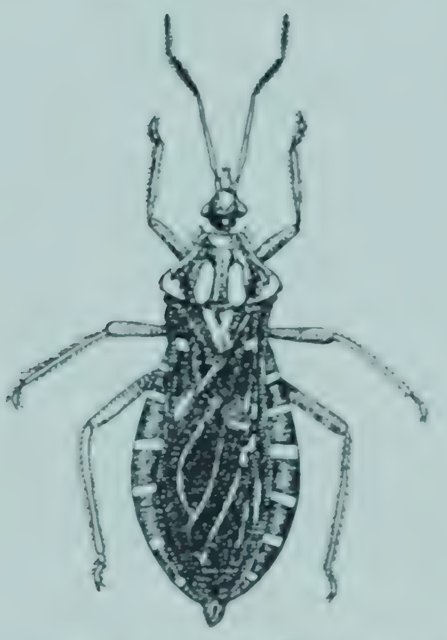

Fig. 156.—Conorhinus megistus.

Order LEPIDOPTERA

As the name signifies, the insects of this order have scale-covered wings, two pairs. The body, legs and other parts also bear scales. The characteristic mouth-part is the long and tubular sucking proboscis, which, when not in use, is carried coiled up like a watch spring.

The lepidopterous larva is called a *caterpillar*. Frequently the pupa is enclosed in a cocoon of silk spun by the larva.

Several moth caterpillars are destructive pests in houses, warehouses and factories. Common species of Clothes Moth are:

Tineola biselliella. Larger Yellow or Webbing Clothes Moth. Family *Tineidae*. Length of wings about ½ inch, the front pair pale yellowish white, the hind pair greyish white. Head light reddish brown. Larva

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[1] Page 573.

a typical caterpillar, with four pairs of prolegs on abdominal segments 3 to 6: it feeds on fur, feathers, stuffed furniture, carpets, etc., makes a tubular sort of web, and pupates in a silken cocoon. The larval period, normally 50 or 60 days in summer, may, depending on temperature and food supply, be prolonged to 3 or even 4 years.

Tinea pellionella. Case-making Clothes Moth. Also a Tineid. Length of wings about ¼ inch: the front pair silky greyish yellow, with or without a small dark spot, the hind pair silky white or grey. Head light yellow. Larva crawls about in its silken case, its head out when feeding and drawn in completely when disturbed: it is thus readily identified.

Borkhausenia pseudospretella. Family Oecophoridae. Becoming a common household moth. Length of wings about ½ inch, the front pair dark brown with two dark spots and a golden lustre, the hind pair whitish grey. The full grown larva is ½ inch long, yellowish white with a brown head and with prolegs on segments 3 to 6: it feeds on cereals, but readily attacks clothes, carpets, linoleum, etc.

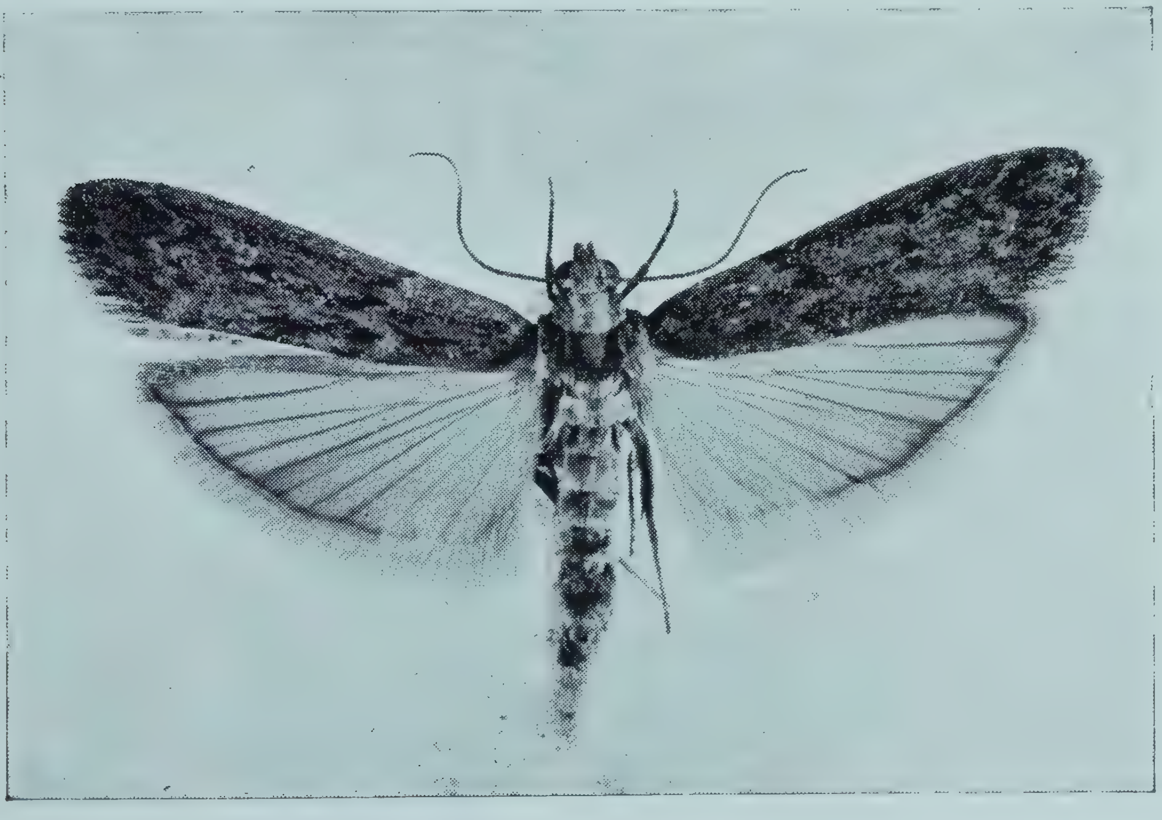

Fig. 157.—Ephestia kühniella (× 4).

As a clothes-moth repellent, naphthalene is generally used: but apparently paradichlorbenzene, employed in the same way, is more effective. It is a white crystalline substance which, at ordinary temperatures, gives off a vapour non-poisonous to man and not injurious to articles of clothing. It is cheap and non inflammable. D.D.T. has lately been tried, but has been found ineffective unless when the infested fabric has been soaked in the spray.

The following species are infesters of food-stuffs:

Sitotroga cerealella. Angoumois Moth. Family Gelechidae. Length of wings about ¼ inch: front pair straw-coloured, hind pair grey.

Larva short (5 or 6 mm. when full grown), stout and white with very small legs and with prolegs on segments 3 to 6. A cosmopolitan pest of stored grain.

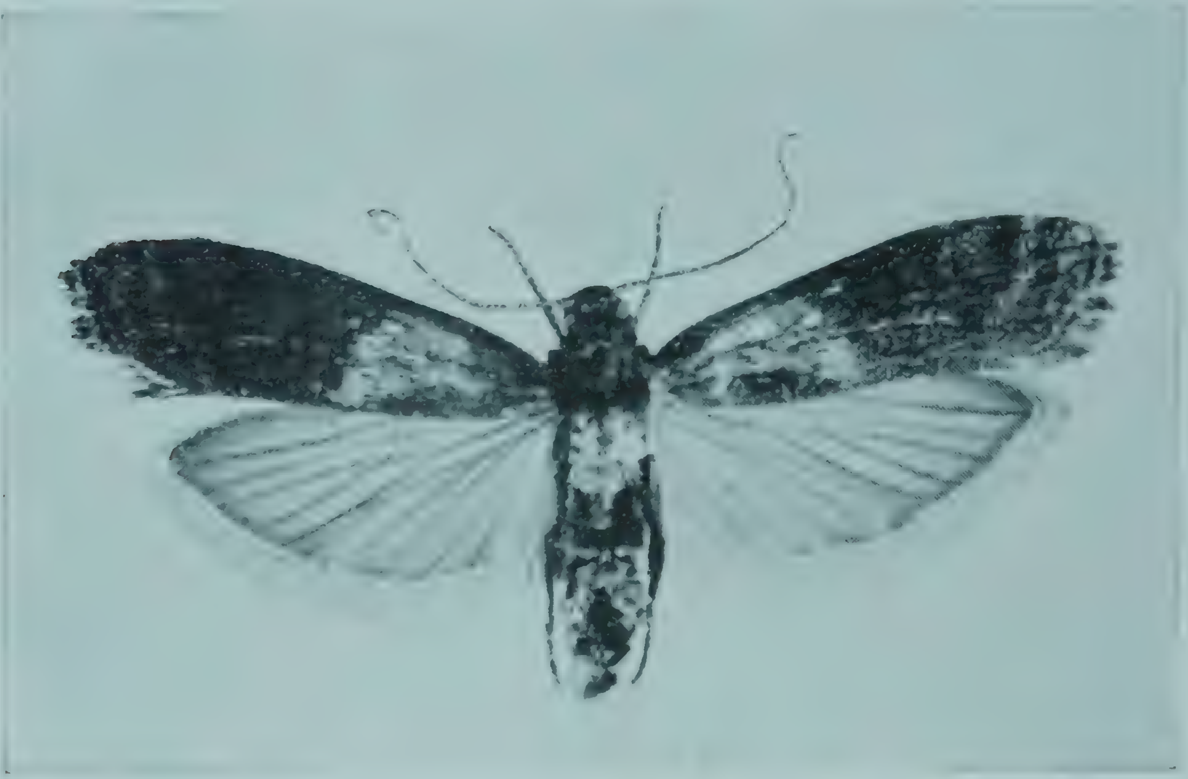

Fig. 158.—Plodia interpunctella (× 4).

Pyralis farinalis. Meal Moth. Family Pyralidae. Length of wings about ¾ inch: the front pair purplish brown, with a broad median yellow cross-band. Larva ½ inch long, dirty white, with a dark head and with the large pronotum and the terminal notum chitinised and dark.

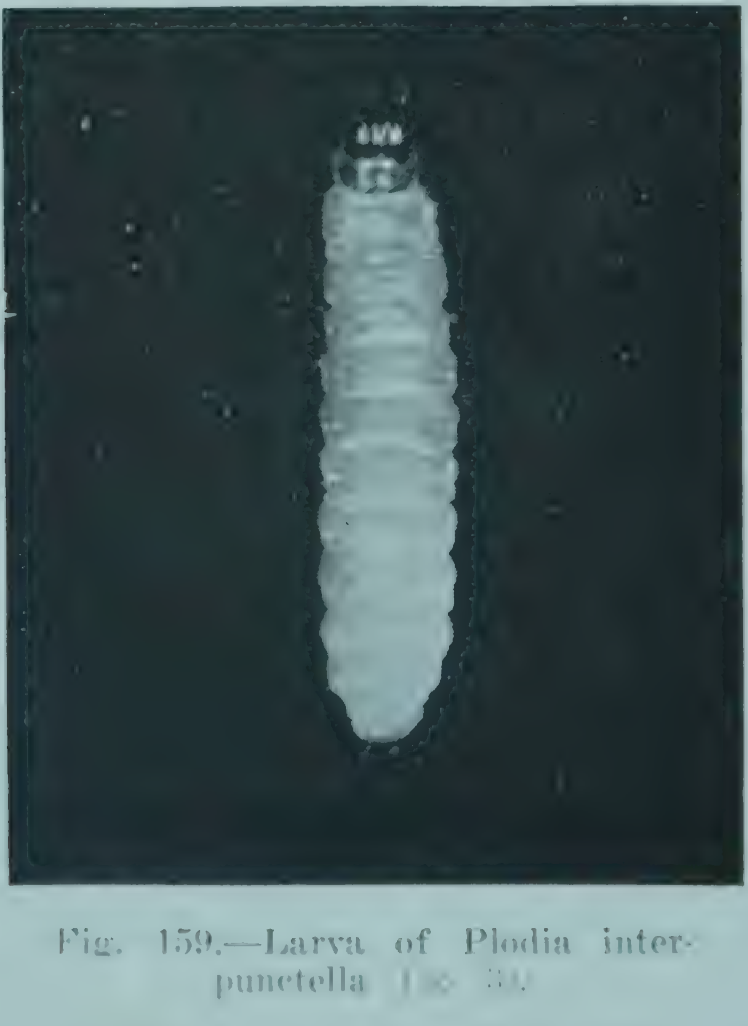

Fig. 159.—Larva of Plodia interpunctella (× 3).

Ephestia kühniella. Mediterranean Flour Moth (Fig. 157). Family Phycitidae. Length of wings more than ½ inch: the front pair pale slate grey with zigzag pale and dark lines across the middle and towards the apex, the hind wings greyish white. Larva pinkish white, head brown, pronotum and terminal notum light brown. A great pest in flour mills, it literally clogs the wheels of industry with its webbing. The infested flour has an offensive smell, and is rendered unfit for use.

Plodia interpunctella. Dried-fruit Moth (Fig. 158). This moth, which belongs to the same family as the last, is another cosmopolitan household and warehouse pest: the larva (Fig. 159) is very damaging at the present time to sultana raisins and other fruits exported from Australia.

Order COLEOPTERA

A beetle is a quite distinct type of insect and easily recognised. With comparatively few exceptions beetles have a very hard or leathery integument, and the two front wings are adapted as hard or horny sheaths, termed *elytra,* which meet close together along the middle line. Hence the name Coleoptera which signifies sheath-wings. The mouthparts are adapted for biting and chewing.

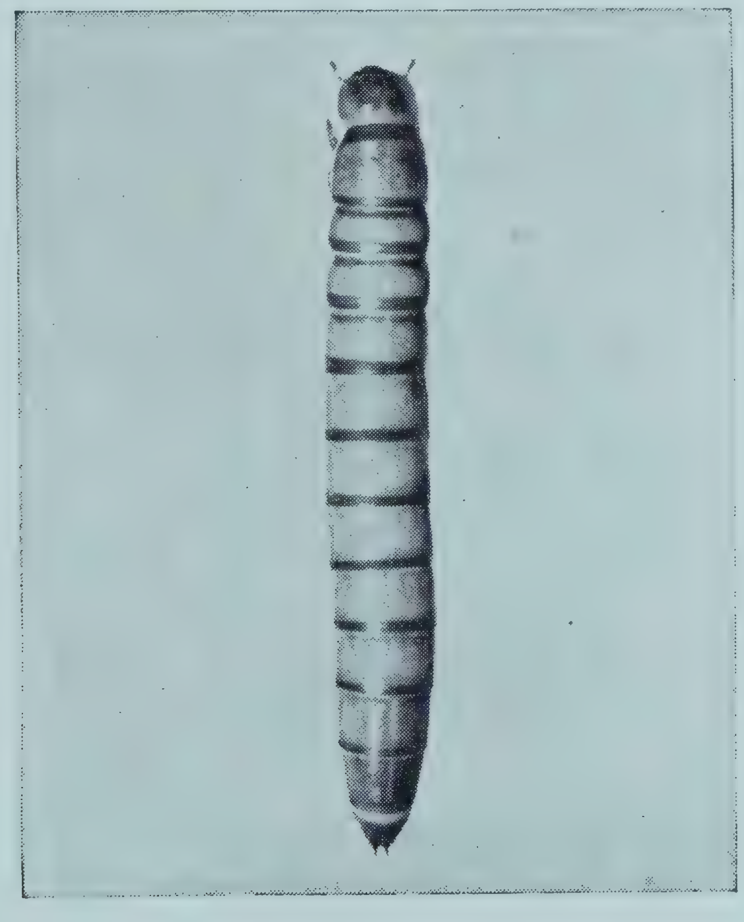

Fig. 160.—Larva of Tenebrio molitor (× 3).

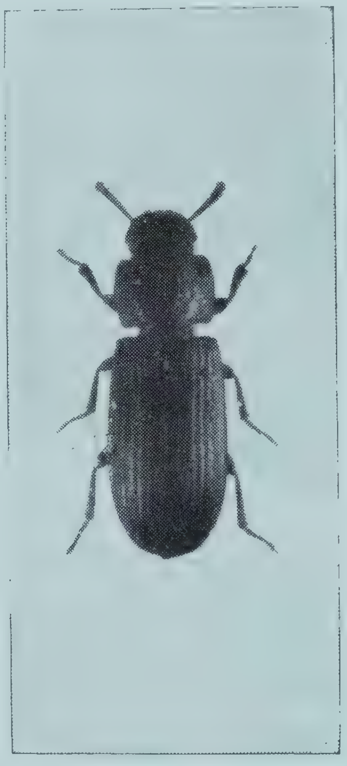

Fig. 161. — Tribolium confusum (× 6)

Laemophloeus ferrugineus, the Red Rust Grain Beetle, is a cosmopolitan parasite of maize, poultry food, wheat, oats, currants and chillies. It is mainly a scavenger.

Tenebrio molitor is a dark brown beetle about ¾ inch long. The larva, about one inch long, occurs in oatmeal and is known as the 'mealworm'

(Fig. 160). Both adults and larvae feed on grain, oatmeal and seeds.

Tribolium confusum is the common household flour beetle (Fig. 161). Infested flour has a pungent odour and is pink coloured, becoming brown on exposure to the air.

Bruchus pisorum, the Pea beetle, is a common pest in warehouses and granaries. Its head, being somewhat produced in front, is rather weevil-like, hence the erroneous popular name of 'pea-weevil.' The eggs are laid on the developing pods and the grubs or larvae pass through to the seeds. Only one grub enters a seed and, when full-fed, it changes to a pupa inside the eaten-out pea, consequently adult beetles are found in many of the infested peas. This pea beetle is often reintroduced into warehouses with imported peas. Dried peas are not usually subject to attack.

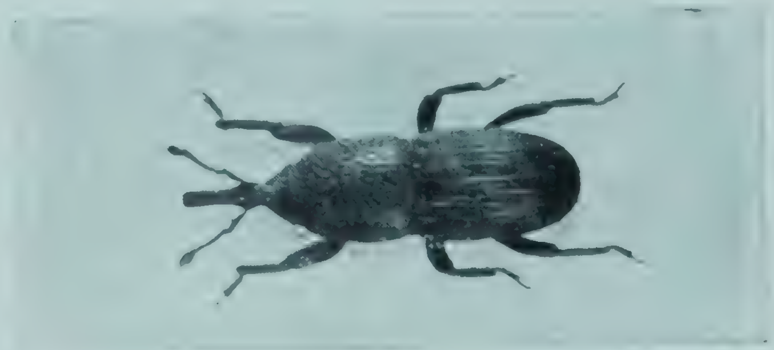

Fig. 162.—Calandra granaria (× 6).

Calandra granaria, the Grain Weevil (Fig. 162), of the Family Curculionidae, is a well known and cosmopolitan pest of stored grain. Length about 3 mm. It has an elongated snout or rostrum and the antennae are elbowed or geniculate, two characteristic features of typical weevils. The larva is very short and stout and humped in form. Using her rostrum the female bores a hole in the grain or seed, usually near one end: and having placed a single egg in the hole, she then seals the opening. One female, during the course of her four months' existence, may lay up to 200 eggs.

Skin-eating beetles of the Family Dermestidae are comparatively harmless, but the larvae of several species are serious factory, warehous and household pests, doing great damage to skins, furs, woollen fabrics, carpets, and the like, and also provisions such as bacon and cheese. Th beetles are of oval form and stoutly built: they are seldom more than inch long and usually dull black or grey, often with a fine pubescence The head is retractile and deflexed. The short and club-tipped antenna may be concealed in a groove under the protonum. The elytra cover th abdomen. The legs are short and retractile. The larvae are unlike thos of other Coleoptera: their shape may be peculiar and their uppe surface is always clothed with hairs, often in freely movable tufts They have, while running, the odd habit of stopping now and then an briskly vibrating their hairs.

Dermestes lardarius (Fig. 163), the Larder or Bacon beetle, is cosmo politan and locally common in provision factories, warehouses an dwellings. Length about 6 or 7 mm. Larva, when full grown, abou

$\frac{2}{5}$ inch long: head almost as broad as the thoracic segments, which are of equal width, and the abdomen tapering gradually to a blunted end: brownish, with many tufts of long and short hairs, and with two dorsal spines, V-like, backwardly directed, and with curved tips, on the second last segment. The larvae are found in hams, bacon, dried fish, especially if stale, dog-biscuits, etc.

Beetles of the Family Anobüdae are destructive to old wood. They range in length from $\frac{1}{10}$ to $\frac{1}{3}$ inch. The larvae are curved, whitish, fleshy grubs.

Anobium punctatum, otherwise *A. striatum,* the Common Furniture Beetle, is the species usually responsible for 'worm eaten' furniture and woodwork in houses. These beetles emerge in June or July, and in a house may then be seen resting or crawling rapidly on the walls and ceilings, and sometimes flying with a slow and heavy flight. They soon begin to pair and a day or two afterwards the females, which are the larger-sized, lay their eggs, a few at a time, in any suitable rough crevice. The grub, when fully grown, is less than $\frac{1}{4}$ inch long, and white with a darker head. The grubs bore roughly at right angles to the surface, and then along the grain of the wood; the powder produced consists largely of angular particles of wood and small oval pellets of excreta. The 'worm-holes' seen are the exits made by the beetles.

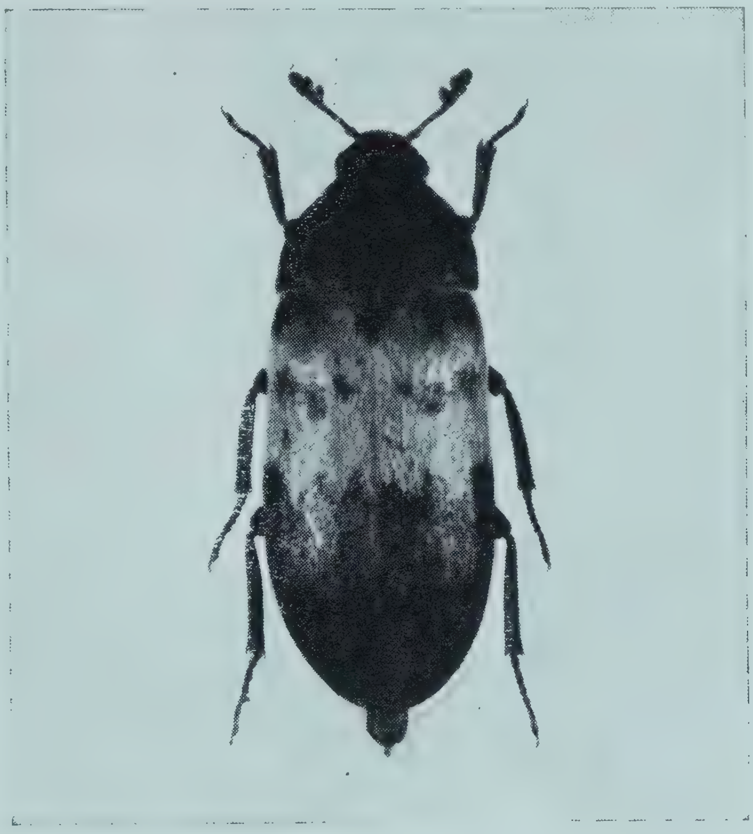

Fig. 163—Dermestes lardarius (× 3).

Xestobium rufovillosum or *tessellatum* is the true Death Watch Beetle. By tapping wood with its head, it makes the ticking sound usually heard at pairing time in April or May. It rarely attacks movable furniture, but is very destructive to old oak or chestnut roof-beams and panelling in old houses and buildings. Length fully $\frac{1}{4}$ inch: dark brown with yellowish-grey pubescence in spots or irregular bands which give it a mottled, tawny appearance: pronotum convex, with broadly flanged sides: elytra without punctures. The larva is similar to that o *Anobium*, but larger, about ½ inch long.

The globular kinds of Anobiids are known as *Spider-beetles*. A very common one in houses is *Niptus hololeucus*, the Yellow Spider-beetle

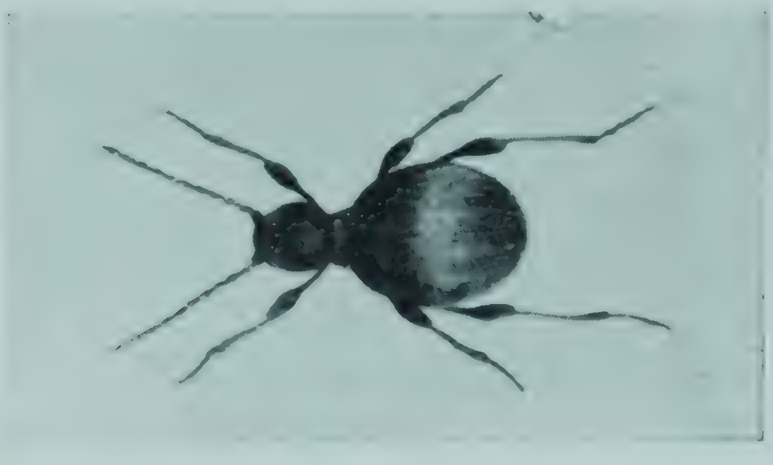

Fig. 164.—Niptus hololeucus (× 6).

(Fig. 164), frequently mistaken for a bug. It is yellowish-brown with silky hairs and about ¼ inch long. The head is hidden under the globular thorax, and the much-larger abdomen is ovoid. The elytra are fused. The larva is like that of Anobium except that it is hairy and the thorax not markedly enlarged. The beetles are usually seen in June and July and again in October and November. Both adults and larvae are normally scavengers and, unless very numerous, not likely to be harmful in any way.

Measures directed to the control of insect parasites in stored food include the hygienic design of granaries and warehouses, the regular and thorough sweeping of floors, the burning of sweepings, the maintenanc of low temperature and free ventilation, the examination of all nev stocks on arrival, the removal of empty sacks from the neighbourhoo of grain and the adequate spacing of piled foods. The 'circum-tracking of each pile by a 4-6 inch floor band of soap-carbolic-jelly may serv to prevent the migration of parasites to other consignments in the store

Should infestation appear, the affected consignment should at onc be removed from the store and other stocks scrutinised. 'Gammexan smoke[1] has proved efficacious in the control of many stored produc pests. The expert advice of the Infestation Branch of the Ministry o Agriculture should immediately be sought, through the medical officer o health, in all major cases of infestation.

In the event of infestation by mites,[2] the floor should be soaked i a solution of 1 lb. sodium carbonate to 1 gallon of water, and allowe to dry over a period of 14 days.

Order DIPTERA

These, the true or two-winged flies, have one pair of functional wing the hind pair being represented by two very small club-like balancers o

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[1] Page 571.

[2] Page 572.

halteres. The mouth-parts are greatly modified and usually in the form of a proboscis for sucking, or for piercing and sucking. The thorax is very compact by fusion of its three segments, the mesothorax forming the largest part. The abdomen also is compact.

Viviparity occurs regularly in two degrees among Diptera:—

1. The larvae is hatched within the uterus of the parent and remains there for a while.

2. The larva is hatched within the uterus and is there nourished to maturity by the secretion of specialised glands.

Table 40 exhibits the main Families and Genera of Diptera which are of medical interest.

Table 40.

ORDER DIPTERA

Genera of Medical Interest

Family.	Genera.
Psychodidae	Psychoda, Phlebotomus (sand-flies).
Culicidae	Culex, Aëdes, Theobaldia, Anopheles.
Chironomidae	Culicoides.
Simuliidae	Simulium.
Tabanidae	Tabanus, Haematopota, Chrysops.
Anthomyidae	Homalomyia (Fannia), Musca, Calliphora, Lucilia, Stomoxys, Glossina, Chrysomyia, Pollenia, Cordylobia, Auchmeromyia.

Members of the family Psychodidae are minute downy flies. Their broad oval-shaped wings are held side-sloping. Commonly they are seen on windows: some, like *Psychoda sexpunctata* and *P. phalaenoides*, frequent sewage works, breeding in chinks of the retaining walls of the sprinkling filters and, when numerous, apt to cause annoyance in neighbouring houses.

Phlebotomus papatasii is the vector of sand-fly fever. It is a minute creature, like a tiny moth, which can pass the 18 to the inch mesh of a mosquito curtain but is stopped by 22 to the inch. Disliking sun and wind, it keeps in the dark by day and bites vigorously at night. A. B. Semple, in combating an epidemic of sand-fly fever at Malta during the Second World War, found D.D.T. in kerosene to be an excellent phlebotomus repressive. Other species of Phlebotomus which convey disease to man are *P. sergenti*, the probable vector of oriental sore, and *P. argentipes*, which has been held responsible for the transmission of kala-azar.

The family Culicidae contains the Mosquitos. In these graceful insects one pair of wings only is functional, the hind pair being represented by two knobs called balancers or halteres. The wings are scaled on their veins and posterior margins. The long antennae are

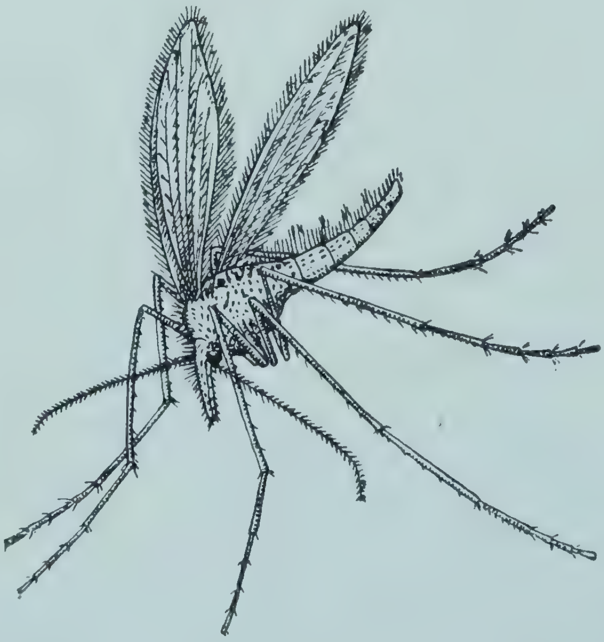

Fig. 165.—Phlebotomus papatasii.

plumose or feathery in the male and pilose or bristly in the female. Th proboscis of the male sucks plant juices: that of the female can pierc the skin and suck blood. The eggs hatch in water. The larva is aquati but breathes air by means of spiracles. The pupa, also aquatic, respires through breathing trumpets. Larval existence lasts from a week to several months, the pupal stage for a few days. The imago lives up to three months, during which time it may travel several miles from its natal water. There are two groups of mosquito, the Culicine and the Anopheline. Their differential points are summarised below and illustrated in Fig 166.

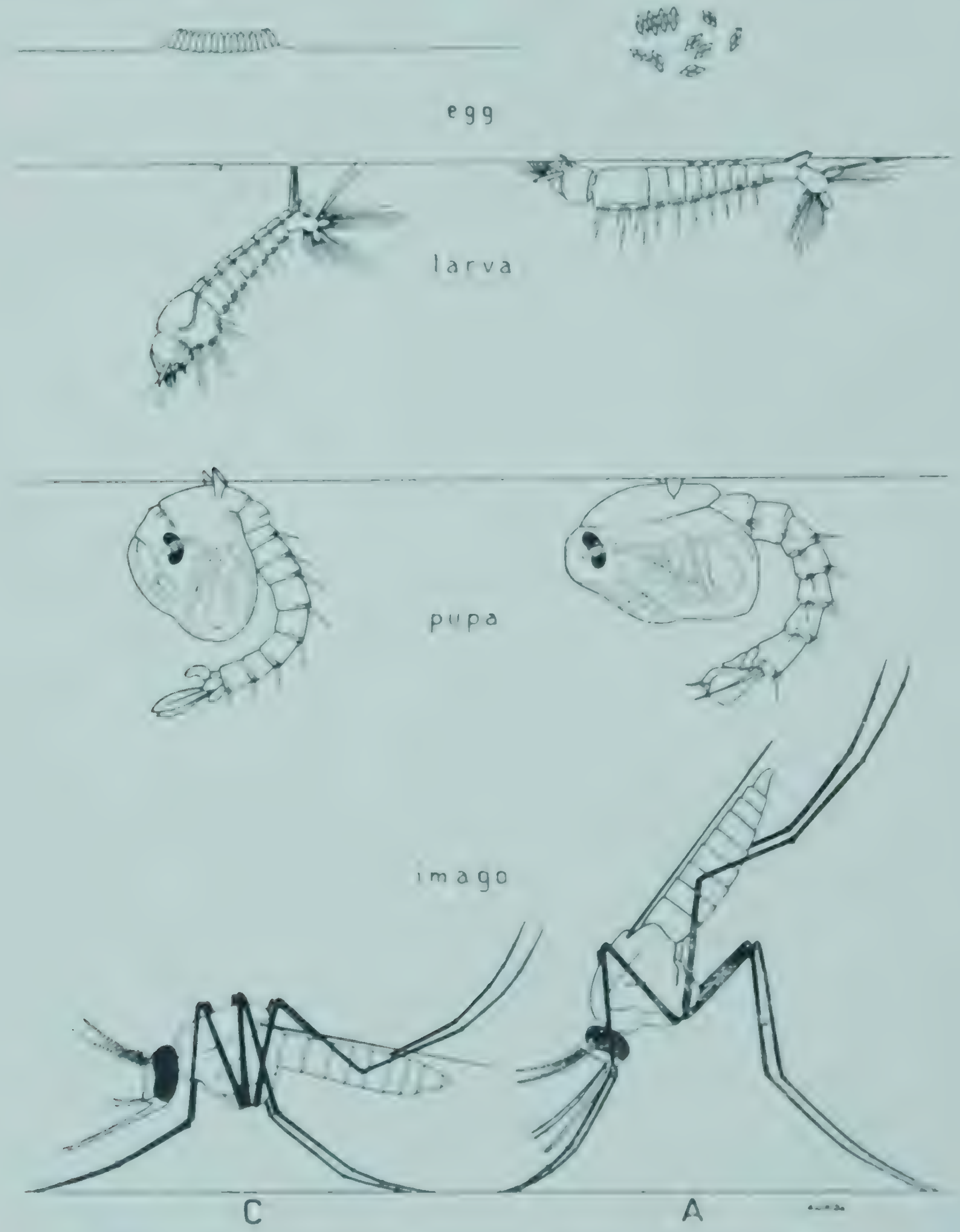

Fig. 166. Life-history Stages of Mosquito.
C. Culicine. A. Anopheline.

		CULICINE.	ANOPHELINE.
EGG	*Disposition*	In Rafts or Solitary	Stellate or Solitary.
	Floats	Absent	Present.
LARVA	*Spiracles*	Siphonate	Asiphonate.
	Posture	Pendent	Horizontal.
PUPA	*Breathing Trumpets*	Narrow	Wide.
	Posture	Rather Vertical	Rather Tilted.
IMAGO	*Palps of Female*	Short	Long.
	Thorax	Broad	Narrow.
	Wings	Usually Clear	Often Spotted.
	Posture	Horizontal	Tilted.

Culicine Mosquitos. *Culex pipiens* (Fig. 168), is the 'common gnat' of England. One strain bites man freely but is not a disease vector. *Culex fatigans,* the domestic mosquito of Africa and the Orient, conveys filariasis. *Aëdes aegypti,* otherwise *A. argenteus* (Fig. 169), formerly *Stegomyia fasciata,* which bears the figure of a lyre in white relief upon its black thorax, is also of a domestic habit, breeding in casual water about houses. It is not a British species. It transmits yellow fever and dengue. The female bites by day or in artificial light, not in the dark. *Theobaldia annulata* is the large 'wood gnat' of England. Its bites tend to become septic and have on occasion proved fatal.

Anopheline Mosquitos. Of the hundred or so anopheline species recognised, some fifty are known to be carriers of malaria. The female usually bites at twilight in the open but at any hour in houses. *Anopheles maculipennis,* the 'spotted gnat,' with six dark spots on each wing, is the commonest anopheline in England. *A. bifurcatus,* a persistent blood sucker, is the commonest in Scotland. Both can harbour the malaria parasite.

The mouth parts of a female mosquito are shown in Fig. 167.

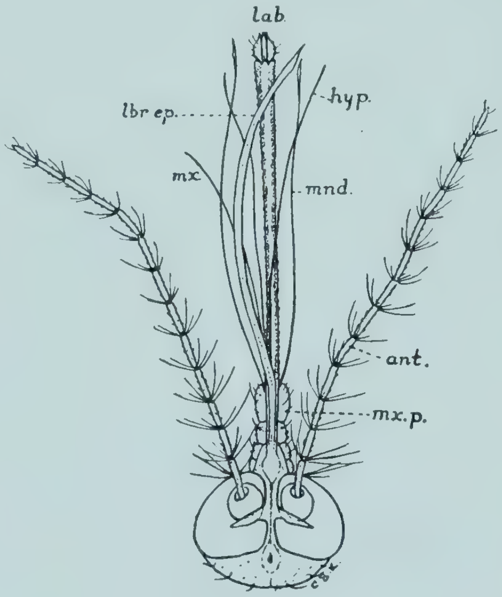

Fig. 167.—Culex. Head and mouth parts of ♀.

ant., antenna; *hyp.*, hypopharynx; *lab.*, labium; *lbr.-ep.*, labrum-epipharynx; *mnd.*, mandible; *mx.*, first maxilla; *mx.p.*, maxillary palp (short).

Breeding places for mosquitoes may be abolished by draining swamps or filling them in with builder's refuse or mud from hydraulic dredging. The sea may be admitted to coastal marshes so as to render them freely tidal. Streams should be channelled in order to prevent pool formation in dry weather. Ditches should be cleared and water weeds in standing or moving water cut away. Surface drainage round houses and the under draining of wet ground should receive attention. Stored water in tanks or barrels about houses should be covered in or screened with a textile or else wire gauze. Discarded tin cans in which water may collect should be gathered and disposed of. Larvae may be asphyxiated by oiling the water which they inhabit, applying 1 ounce of paraffin per 15 square feet of surface. Obstructive reeds, if they prevent oiling, should be burned out with a flame-thrower. Ponds, streams or public reservoirs which have been cleared of weed may be stocked with larvicide fish, such as sticklebacks and minnows or species of *Gambusia. Lucania* is good in brackish water and *Dormitator* effective against *Aëdes.* In stocking chlorinated water, there is danger to the fish if residual chlorine exceeds 1·5 p.p.m. To poison larvae, $K_2Mn_2O_8$ or $CuSO_4$ may be introduced into non-potable waters, or a mineral dust containing 1 per cent. of Paris green (aceto-arsenite of copper), blown out over pools, or 2 ounces of 0·1 per cent. D.D.T. emulsion per acre may be sprayed upon the surface. Imagos in houses may be killed with a whisk on dark hangings put up to attract them, or apartments fumigated with SO_2 gas, 2 lbs. of sulphur being burned per 1000 cubic feet of space. A spray of pyrethrum two parts in CCl_4 four parts with paraffin one part may also be employed. A recent development is the 'aerosol bomb' which contains up to 5 per cent. of D.D.T. in liquid dichlor-difluor-methane, together with pyrethrins. When the nozzle of the bomb is opened, the compressed liquid instantly vapourises, forcing the insecticide into the atmosphere in the form of a fine mist. The bomb, which can be of pocket size, is particularly useful in mosquito-infested living quarters, aeroplanes and other enclosed spaces. 'Gammexane'[1] is lethal for mosquitos, and may be used as a spray or in the form of smoke. For protection during sleep, curtain of 18 mesh to the inch should be utilised. Houses and steamers o inland water may be rendered mosquito proof with galvanised wire o brass or bronze screens. Fans may be set to blow outwards at entranc doorways. European residences should be sited to windward of the nativ quarters and at least ¼ mile away. If a sheet of water too large fo oiling is breeding anopheline swarms, cattle stalled between it and th dwelling house will absorb the attack of the zoophil strains. When ou after dark, people should wear mosquito-proof veils, gloves and anklets Camphor, eucalyptol or oil of citronella may, if desired, be applied t the skin. No extensive anti-mosquito campaign for the control of malar

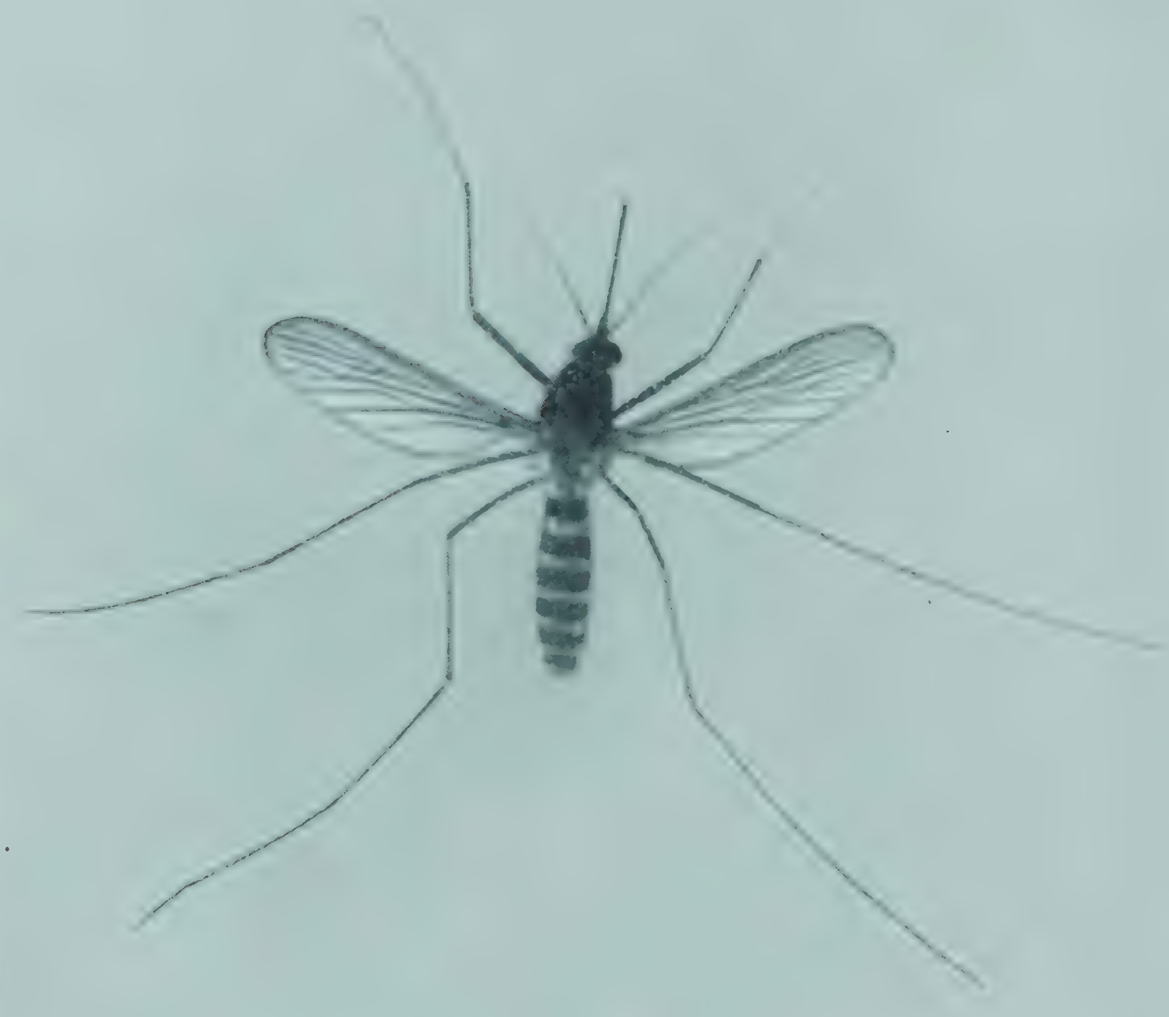

Fig 168.—Culex pipiens ♀.

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[1] Page 573.

should be undertaken without knowledge of the local species and the natural history of each. It is possible to exterminate one type only to find its place promptly filled by another, which thrives under the new conditions established and may prove to be an even greater pest than its predecessor.

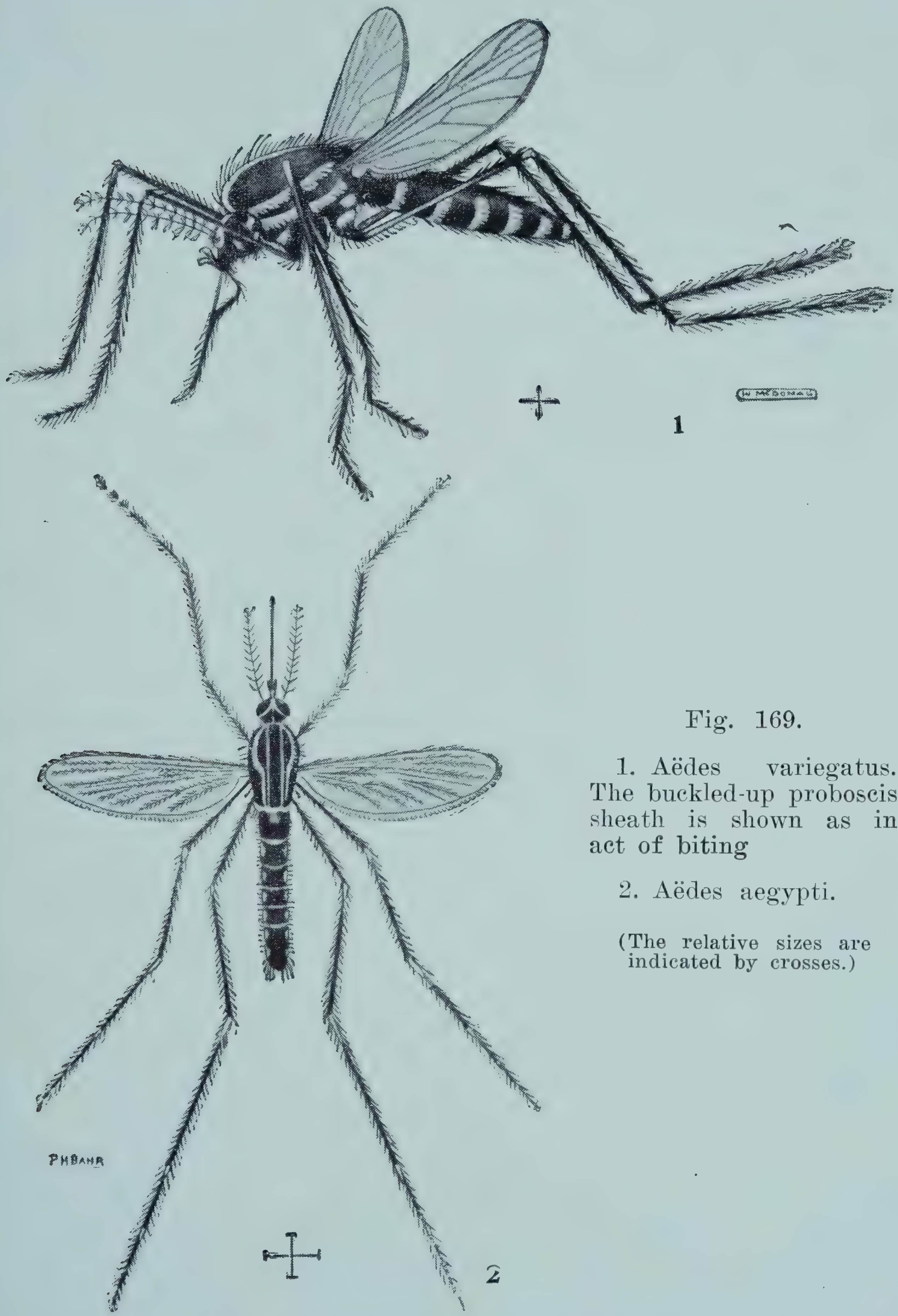

Fig. 169.

1. Aëdes variegatus. The buckled-up proboscis sheath is shown as in act of biting

2. Aëdes aegypti.

(The relative sizes are indicated by crosses.)

The family Chironomidae are the midges, which cause great annoyance during the summer months especially in the evenings. *Culicoides pulicaris* and *C. arcuatus* are common British midges. *C. austeni* transmits a type of filariasis. Good results in midge suppression have lately followed the use for personal prophylaxis of dimethyl phthalate cream.[1]

Simulium means a member of the family Simuliidae, known also as Black Flies and Buffalo Gnats. They are small, stout-bodied flies,

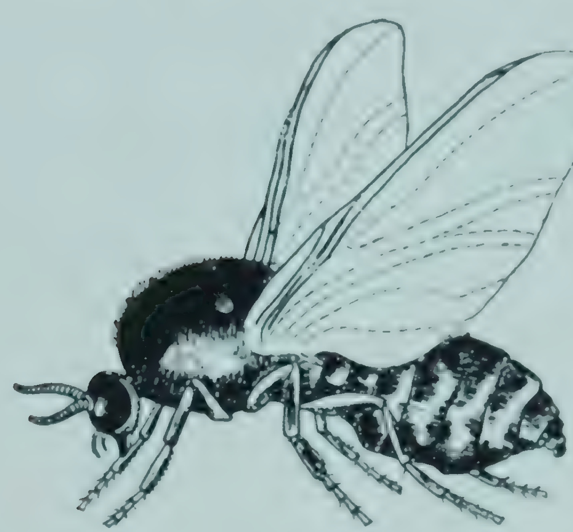

Fig. 170.—Simulium.

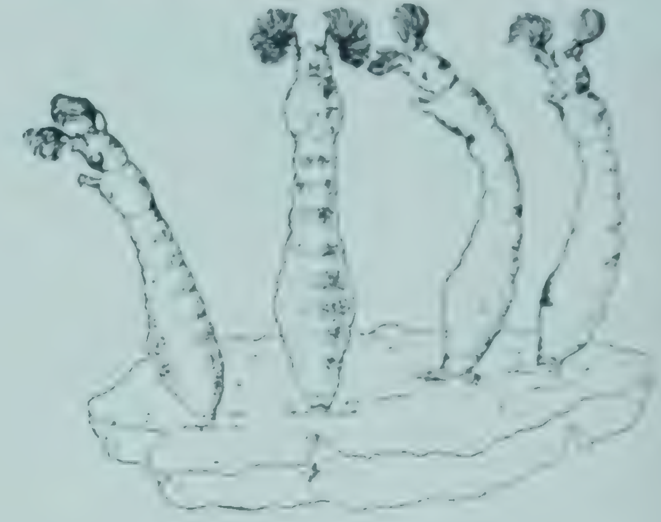

Fig. 171.—Larvae of Simulium.

usually black, and ranging from 1·5 to 3 mm. in length (Fig. 170). The humped thorax tends to overreach the head, giving them a hunch-backed appearance. Another characteristic is the short, stumpy, upturned proboscis, hence *Simulium* (snub-nosed). They have short and straight antennae, short and stout legs, and their large translucent wings, broad and rounded, have the anterior veins markedly thickened and the others faint.

Simulium occurs in swarms in the vicinity of streams. The eggs are laid in gelatinous masses on aquatic plants or on stones in or near *running* water, in which the larvae live submerged. The larva (Fig. 171) is cylindrical and somewhat swollen at the posterior end. The head bears eyes, small antennae, mandibles an maxillae, and a pair of graceful filamentous fan-lik organs (mouthbrushes) for securing food. There is ventral pseudopod on the thorax and at the end of th body a disc-like sucker, above which is the anus wit three small lobe-like retractile rectal blood gills. Thes larvae are usually seen in groups and erect, attached b the sucker, on stones and water plants. When about t pupate they enclose themselves in a semi-transparen cocoon made of salivary secretion: it is cone-shape with one side flattened for firm attachment to a leaf o stone. The head of the pupa (Fig. 172), and also part o the thorax bearing two conspicuous tufts of respiratory filaments, projec from the open top of the cone.

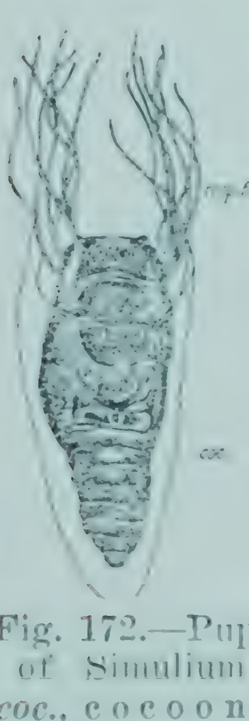

Fig. 172.—Pupa of Simulium. *coc.*, cocoon; *resp.f.*, respiratory filaments.

The distribution of the Simuliidae is world-wide. In some countrie the females of certain species are a serious scourge, attacking huma beings and driving cattle and horses frantic.

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[1] Recent experiment suggests that veils and gloves impregnated with dimethyl phthala preparations are more effective for outdoor workers in midge-infested areas.

Simulium damnosum, the ‘mooli’ or ‘kimteb’ of Equatorial Africa, is a most vicious biter. It has the habit of crawling down the neck and up the arms and legs. In West Africa it is the vector of *Oncocerca volvulus* which causes in man oncocerciasis, characterised by subcutaneous nodules. *Simulium dinelli* and *S. samboni* are the suggested vectors of the oncocerciasis of Guatemala.

To destroy simulium larvae the beds of streams should be cleared. Since the larva is water-breathing the usual surface oiling is useless: but phinotas oil, which sinks to the bottom, has been found effective. Tar ointment is used to protect cattle from the imago. For man, veils and close fly-proof clothing may on occasion prove of some service.

The family Tabanidae, or gadflies, are bristleless flies, mostly large, with broad heads, powerful mouth parts (Fig. 173), robust flattened bodies and strong wings. They are powerful fliers: they abound in wooded districts and their distribution is world-wide. The blood-sucking females of many species attack Man and animals: the males frequent flowers and feed on the nectar.

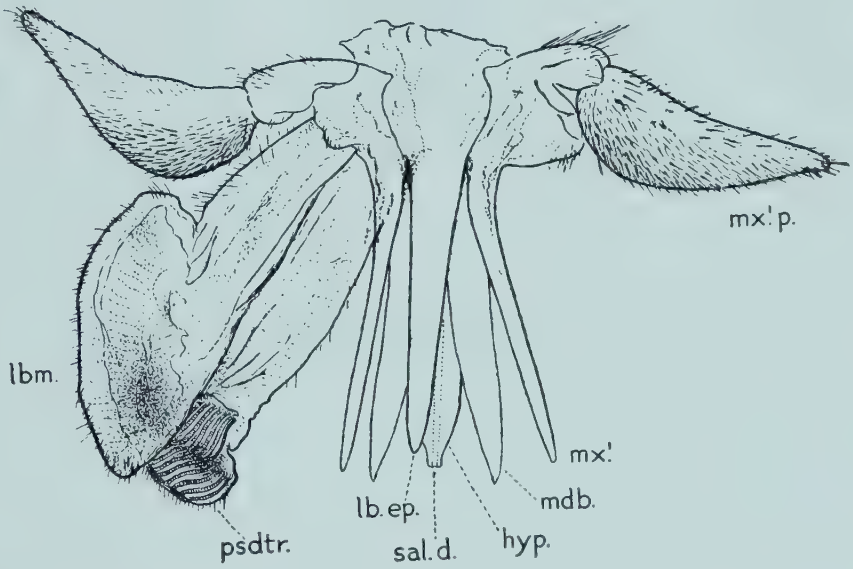

Fig. 173.—Mouth parts of Tabanid.

lbm., labellum; *p.sdtr.,* pseudo-tracheae; *lb.ep.,* labium epipharynx; *sal.d.,* salivary duct; *hyp.,* hypo pharynx; *mdb.,* mandible; *mx.,* maxilla; *mx.p.,* maxillary palp.

The head is always convex in front and markedly concave behind, and most of its area is occupied by the greatly extended and brilliant eyes, holoptic in ♂, dichoptic in ♀. The antennae are very short. The third antennal segment (flagellum) is subdivided: its proximal part is laterally compressed and bears a characteristic basal process: its distal part is curved upwards. The wing may be clear, or clouded with characteristic markings.

Tabanus striatus, an Oriental gad fly, transmits the horse trypanosomiasis known as Surra.

Haematopota pluvialis is the ‘cleg’ of Scotland. It is about ½ inch long and has marbled wings.

Chrysops dimidiata, the mangrove fly, transmits Loa loa, the filarial agent in Calabar swelling. *C. discalis*, the Deer Fly, is the vector in America of tularaemia, or Deer Fly Fever.

Gadflies may be destroyed by oiling pools which they frequent. The insects, skimming the surface of the water, become coated with the oil which blocks their spiracles. Cattle may be protected by the use of ointments containing tar, fish oil or equivalent substances.

The Family Anthomyidae are small to medium-sized flies, usually dull greyish or dark brown, and mostly like *Musca*, the common house fly, in general appearance. Two species are of medical interest.

Homalomyia canicularis, otherwise *Fannia canicularis*, is the Lesser House-fly. The male nowadays is usually more abundant in our houses than the common house-fly. The female seldom enters houses. The Lesser House-fly is about two-thirds of the size of *M. domestica* and has a brown or blackish-grey thorax, with three black dorsal stripes, which are indistinct in the male but distinct in the female. The male abdomen is narrow and conical with the basal segments translucent yellow: the female abdomen is rounder and uniformly greenish. The arista is bare. The face of the male is silvery white. The wings in repose overlap considerably.

Homalomyia lays its eggs in decaying organic matter, chiefly vegetable or fruit. The full-grown larva (Fig. 174) is 5 or 6 mm. long, dull yellow, distinctly flattened, broadest from about the middle to the obliquely-truncated posterior end. It has three longitudinal ten-paired series of long and pointed fleshy processes, which look like spines.

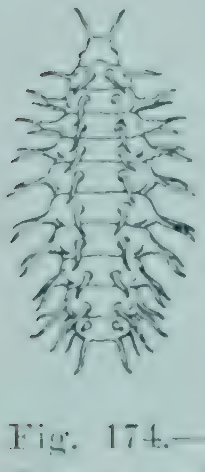

Fig. 174.—Larva of Homalomyia.

The Muscinae are a very cosmopolitan sub-family of the Anthomyidae to which belong the ubiquitous House-fly and the dreaded Tsetse. The Muscinae are generally of moderate size: they are never elongate and neither bare nor very hairy, and most of them are dull-coloured, though some are metallic blue or green. Certain species are piercing and blood-sucking flies, several are germ-carriers and active pathogenic agents. The maggots also of a number are the cause of myiasis.

Musca domestica (Fig. 175), the Common House Fly, breeds in horse manure and damp refuse material including the excreta of man and the pig. The eggs, which are 1 mm. long, are laid in clutches of 100 to 150. In the tropics up to twenty clutches may be laid in a month. The larva hatches out of the egg in from 1 to 3 days. Under favourable conditions it is full grown in a week, when it begins to change into the pupa (Fig. 176). Pupal existence may extend to a fortnight. The lifetime of the imago is a month or more. The adult house fly is ¼ inch in length. Its ground colour is mouse grey with black stripes on the thorax an abdomen. Its mouth parts are soft and adapted for sucking. Flie defaecate while they suck. They practise regurgitation from their crop They soften soluble food stuffs such as sugar by wetting them with thei saliva. Flitting as they may frequently do from the faeces of man to hi food, they may readily convey the infective agents of such diseases a the typhoid and paratyphoid fevers, amoebic and bacillary dysenter cholera and epidemic diarrhoea. They may also transmit, by direct inoculation of surfaces, yaws, trachoma, contagious ophthalmia and oriental sore. In Britain flies are most in evidence from July to September. Then the first frosts thin their numbers and the fungus *Empusa* muscae kills off the rest. The race of flies carries over the winter in a prolonged pupal stage.

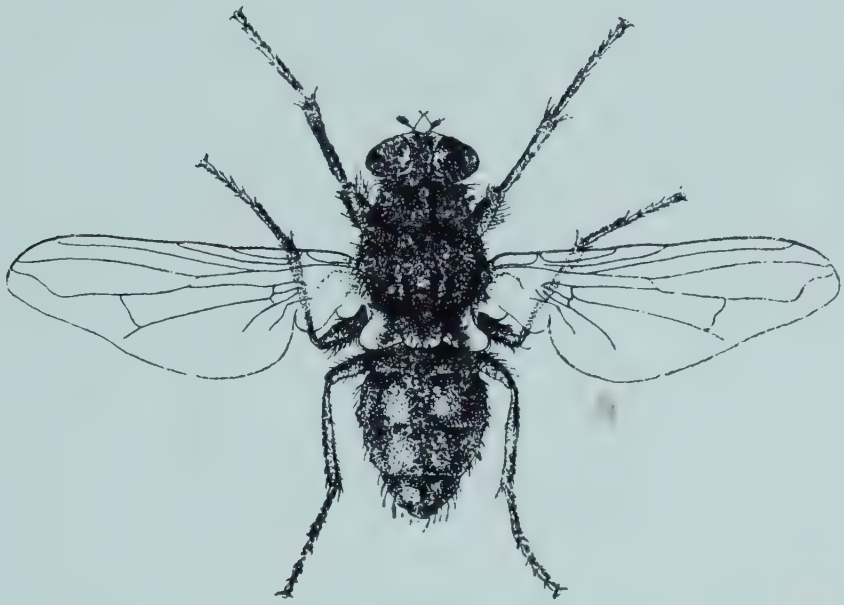

Fig. 175.—Musca domestica ♀.

To prevent house flies from breeding, stable manure should be close-packed on an impermeable platform and watered if necessary. The heat which develops kills the larvae. A concrete gutter round the platform filled with water or 5 per cent. cresol solution will dispose of any larvae endeavouring to migrate. Another plan is to keep the manure covered with sacking soaked in heavy oil. A further method is to spray it with 5 per cent. cresol solution 1 gallon per square yard, or with borax solution $\frac{1}{4}$ lb. to the gallon, allowing

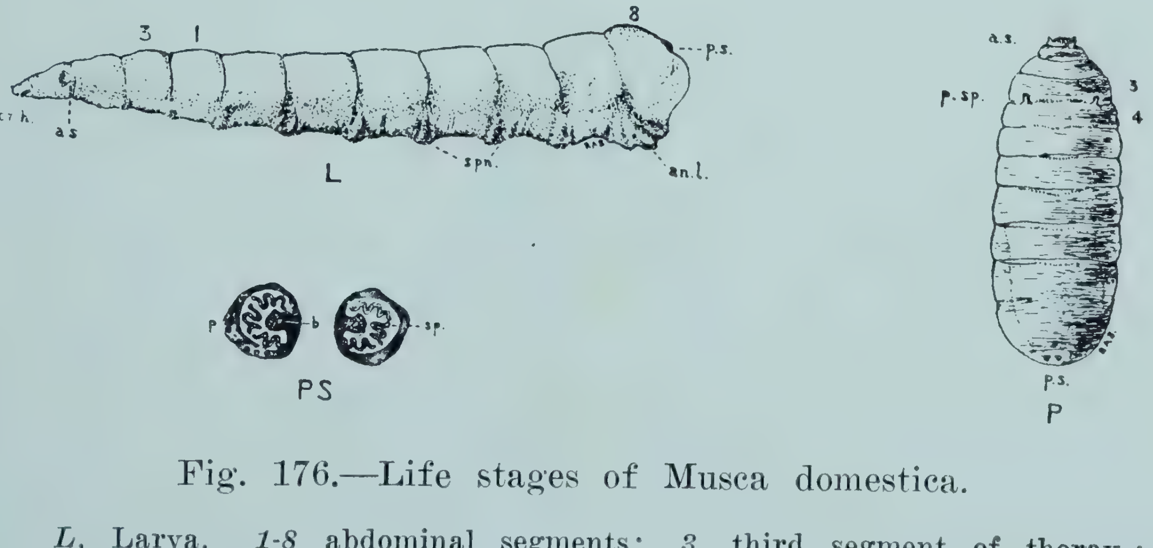

Fig. 176.—Life stages of Musca domestica.

L, Larva. *1-8* abdominal segments; *3*, third segment of thorax; *a.s.*, anterior spiracle; *an.l.*, anal lobe; *or.h.*, mouth-hook; *p.s.*, posterior spiracles; *spn.*, spinules. *P.*, Puparium. *a.s.*, larval anterior spiracles; *p.s.*, pupal spiracles; *p.sp.*, larval posterior spiracles; *3*, metathorax; *4*, first abdominal segment. *PS*, Posterior spiracles enlarged. b., 'button'; *p.*, peritreme; *sp.*, sinuous spiracular slit.

2 gallons per 9 cubic feet. Household refuse should be kept as dry as possible. Ashpits, if any, should be dark, and the lids of ashbins should be close fitting. Imagos may be trapped in a wire gauze fly-balloon baited with a wet paste of sugar and cheese. Tangle foot is an adhesive

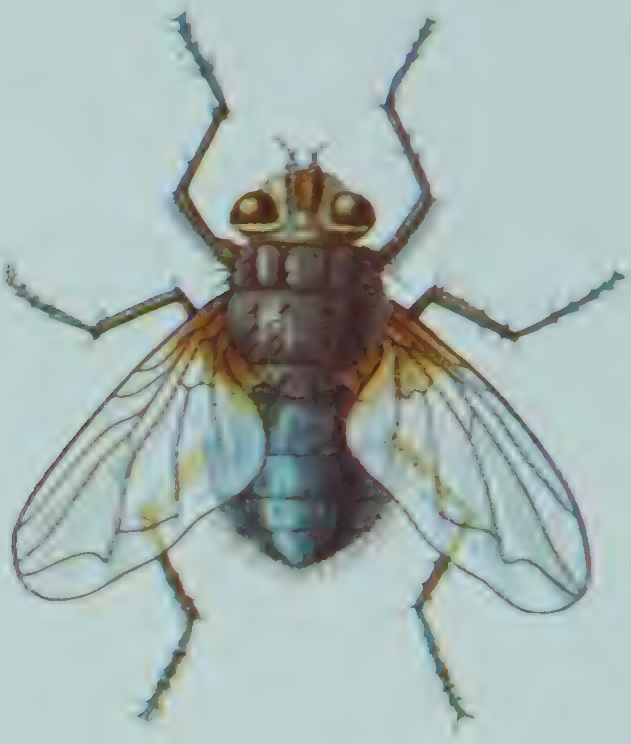

Fig. 177.—Blow Fly.
Calliphora erythrocephala.

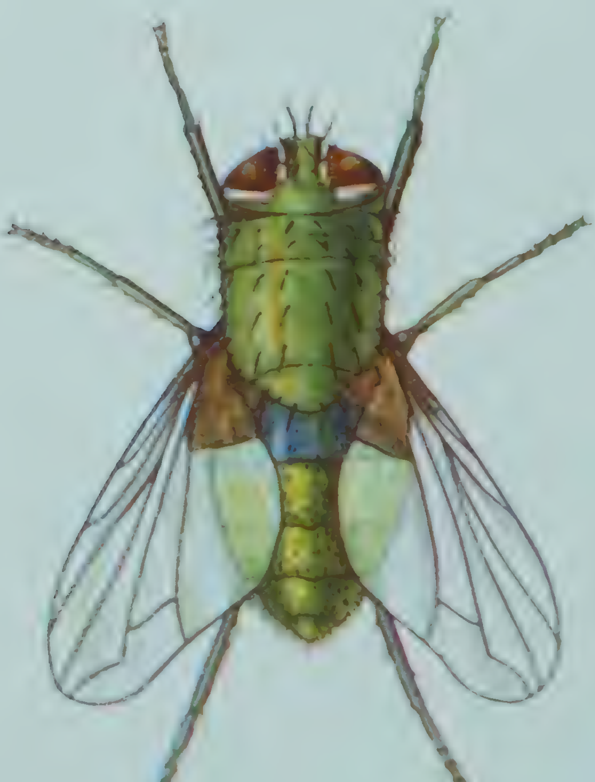

Fig. 178.—Sheep Maggot Fly.
Lucilia sericata.

substance prepared by heating 5 parts of castor oil with 8 parts of powdered resin, without boiling, till the resin is dissolved. It is applie while hot to stout wires or glazed paper. The wires after burning ca be charged again. Fly poison may be made by mixing formalin drachms with sugar 1 ounce in 1 pint of lime water. The mixture is exposed on discs of blotting paper kept wet by strips of the same material dipping into wide-mouthed bottles: or else set out in closed tins with wicks drawn through perforations in their lids. D.D.T., 5 per cent. in kerosene, and the D.D.T. aerosol are also effective, especially for flies in rooms. 'Gammexane'[1] is worthy of trial. Whisks, consisting of a wire gauze racquet mounted on a wooden handle, may be used. Larders and milk stores should be fly-proofed with wire gauze or netting. Yellow window glass for larders acts as a deterrent to flies. Milk or similar food in dining rooms, if flies are present, should either be under a wire gauze frame or covered by a square of muslin weighted with glass beads. Scrupulous cleanliness of the kitchen premises and tidiness of the whole house and its surroundings are discouraging to house flies.

Calliphora erythrocephala, the common blow fly (Fig. 177) or 'blue bottle' of Britain, has the contours of the house fly but is larger and of a metallic blue-black colour. Normally it is an outdoor fly but it frequents houses on occasion. The eggs are laid on fresh or other meat, or neglected wounds, on which the larvae hatch out as maggots.

Lucilia caesar, the 'green bottle,' is a common outdoor fly, occasionally seen in country houses. Its colour is a brilliant gold or vivid green. Its larvae infest wounds.

Lucilia sericata, the 'sheep maggot fly' (Fig. 178), closely resembles *L. caesar.* It occurs in Britain and is widespread in Africa and the East. It is a serious pest of sheep, laying its eggs in their soiled wool or on their feet. In China it attacks man only.

Stomoxys calcitrans, the Stable Fly, to the casual observer looks like a house fly. It may however be distinguished by a number of differential marks, including the 5 dark spots on its abdomen and its stiff jutting proboscis which is adapted for piercing and sucking blood. In this country it frequents pastures and farm yards. It is an unwearying persecutor of horses and cattle, and often attacks man also.

Glossina. The tsetse flies (Fig. 179) of the genus *Glossina* are exclusively African, except *G. tachinoides* which is found in Southern Arabia also. Their geographical range is between 18° N. and 31° S. They frequent the so-called fly belts, patches of forest and brush where there is shade with moist heat. They are usually day-time biters. The normal food of both sexes is vertebrate blood. The female is viviparous, producing at each birth a single larva, which when dropped on the ground at once burrows into safety and enters into the pupal state (Fig. 180). Species of tsetse inoculate man with the African sleeping sickness, the natural reservoir hosts of which include antelope and other game. Transmission may take place mechanically, but usually the trypanosome undergoes part of its life cycle in the body of the fly. The Gambian form of sleeping sickness is conveyed by *G. palpalis,* aided by *G. tachinoides:* the Rhodesian type by *G. morsitans* and other species. *G. morsitans* carries also the horse sickness 'nagana.'

As Glossina does not, like the mosquito, present a vulnerable larval stage, any methods for its repression must be directed against the imago. Fly belts in districts should be located, and the brush cut for 30 yards from the edges of water. The Portuguese island of Principe in the Bight of Biafra, with an area of 48 square miles, was cleared of *G. palpalis* in a few years by organising, among other measures, jungle marches of Africans wearing a back-piece of dark coloured bird-limed cloth to which the flies were attracted and stuck fast. In sleeping sickness areas the houses of Europeans and also lake and river steamers should be fly-proofed with non-corrosive screens. Puttees should be the constant wear, and persons requiring to cross fly belts should arrange to make the transit by night.

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[1] Page 573.

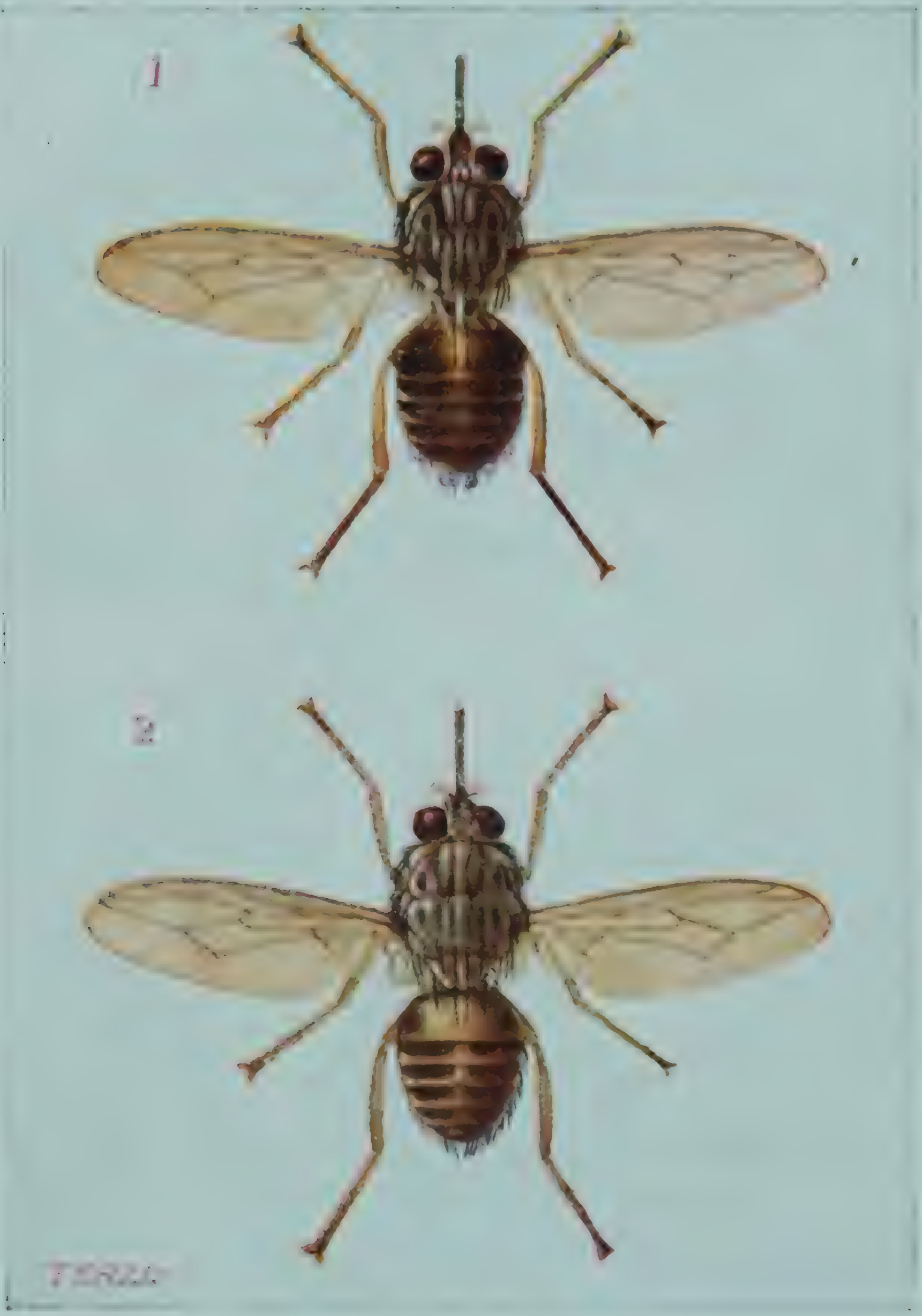


Fig. 179.—Tsetse Flies.

Myiasis is the term applied to the infestation of the body of man by the larvae, or 'maggots' as they are sometimes called, of certain flies. The graver types of invasion are rare in Britain and the gravest happily unknown. *Intestinal Myiasis* is usually due to the chance presence of fly eggs or larvae in food consumed by man. Under such conditions the larvae of the common house fly, of the lesser house fly *Homalomyia canicularis,* and of kindred species may occur in the alimentary tract and produce digestive derangement. The *Skin Myiases* are more troublesome. The larvae of *Hypoderma bovis,* the warble fly, which normally frequents the ox in this country, may penetrate the skin of man, and moving about below it occasion ‘creeping myiasis.’ *Dermatobia cyaniventris* is common in South America. Its eggs are borne by mosquitos and other insects and arachnids. When the vector settles upon its victim the dermatobia larva emerges from the egg, penetrates the skin and gives rise to a boil-like swelling, not unlike a warble, which remains until the larva drops to the ground for pupation. The *Cranial Myiasis* tend to be severe and may be formidable. *Lucilia sericata,* the sheep maggot fly, is a congener of Lucilia caesar. The female may oviposit on the untended wounds of man or round his natural orifices. In Essex lately thirty-one maggots of this species were recovered from the ear of a farm employee. *Chrysomyia bezziana* is the Old World screw-worm fly. The female in India lays her eggs within the nostrils of man and the resulting maggots or screw-worms invade the nasopharynx. *Chrysomyia macellaria,* the New World screw-worm fly, causes grave or fatal illness in tropical America. The female plants her eggs in the nostril, and the emerging maggots or screw-worms, which are armed with powerful mouth hooks, may eat their way into the nasal sinuses or destroy the middle ear. *Wohlfahrtia magnifica* occurs in Southern Europe, Asia and Africa. The female being viviparous, can eject her charge of maggots directly into the nostril. The ensuing tissue destruction may end in a revolting death.

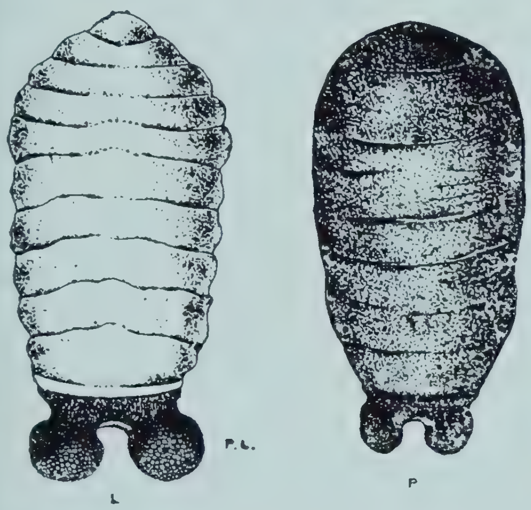


Fig. 180.—Larva and Pupa of Glossina.

The *Order* Siphonaptera or Aphaniptera is that of the Fleas, which are temporary, or intermittent, blood-sucking ectoparasites of birds and mammals including Man. They are of medical interest because certain species are germ-carriers, and their special importance is their connection with plague.

Fleas are wingless with the body laterally compressed, except Sarcopsyllidae. The integument is strongly chitinised and set with hairs, some species having also ‘combs’ of tooth-like spines on the cheek or ‘gena,’ or upon the pronotum, or on both these parts. The head is relatively small, eyes, when present, also small, the antennae short and stout and lodged in grooves, and the mouth-parts adapted for piercing and sucking. There is no neck, the head being broadly set on the thorax which has three distinct separate segments. The conspicuously large abdomen is solidly based on the thorax and bears a peculiar pincushion-like dorsal sense organ. The legs are well developed and have very large coxae. The lateral compression, the recession of the antennae and

the power of the legs are adaptations for rapid movement among th
hairs or feathers of the host.

The head of an ordinary flea is rounded in front, but in fleas (*Sarcopsyllidae*) which attach themselves firmly to their hosts the head is angular in outline and the front is straight. The latero-ventral border, *i.e.* the lower edge of the gena, is wide and may bear a set of tooth-like spines, the genal comb, as in *Ctenocephalus canis*. The short inconspicuous antennae are lodged in oblique grooves behind the eyes: the terminal portion of the antennae is club-shaped and divided into rings.

The eggs of the flea, resembling sifted sugar, are visible to the naked eye and are dropped casually, usually in the host's habitat. The larva (Fig. 181), when full-grown, is about 4 mm. long. legless and worm-like with a small dark head and thirteen similar body segments. It is sparsely hairy, there is a thin circlet of bristles on each segment, and specially diagnostic are the anal struts, two blunt-pointed hooks at the end of the body. Flea larvae are very active. They feed on organic debris. The pupa, hump-backed and resembling the adult, is usually within a dust-coated cocoon. Flea pupae are very sensitive to mechanical disturbance: they await the opportune moment for emergence.

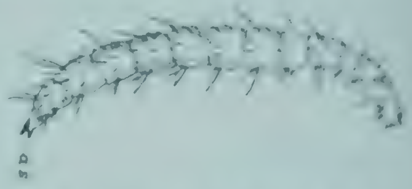


Fig. 181.—Larva of a Flea.

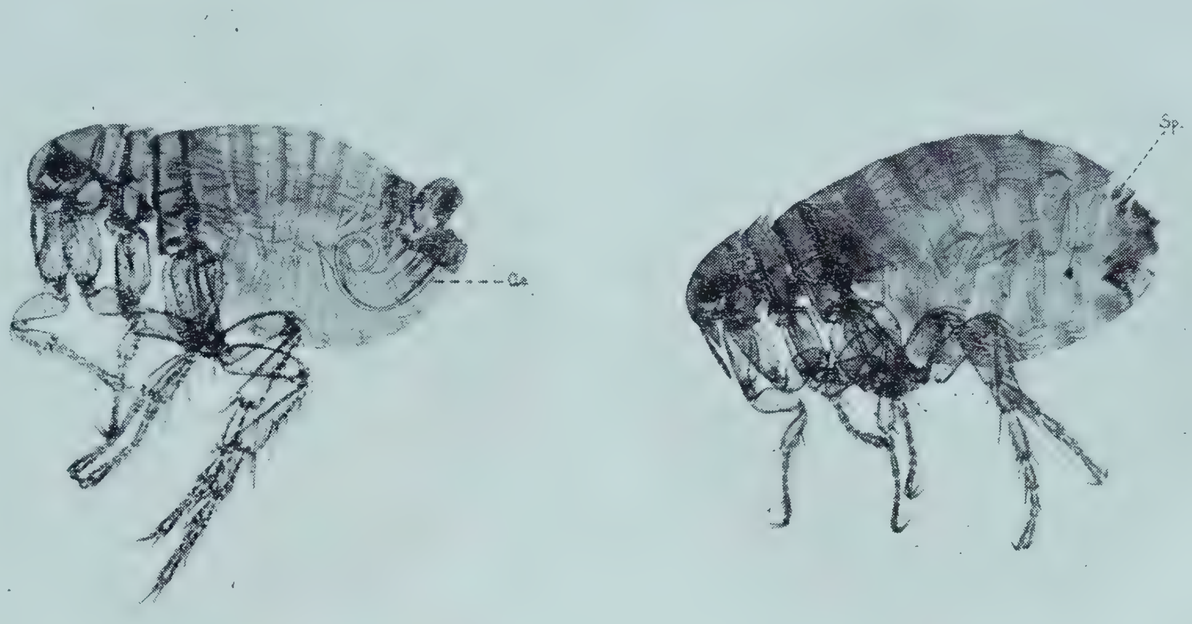
a.s., anal struts.

The two important *families* of fleas are the Pulicidae and the Sarcopsyllidae, the latter highly specialised.

Pulex irritans (Fig. 182), the common flea of man, bears no combs. It undergoes a complete metamorphosis. The eggs look like sifted sugar. The larval stage, spent in cracks about floor boards, may last 200 days. The cocoon-invested pupal stage may carry on for 600 days. A starved imago in a moist atmosphere may survive for 100 days. Hence the persistent flea infestation of untenanted houses. The human flea, though it is able to harbour *Bacillus pestis*, is in general unlikely to pick up the infection. The flea's bite on the skin of man shows a reddish halo round a minute red punctum.

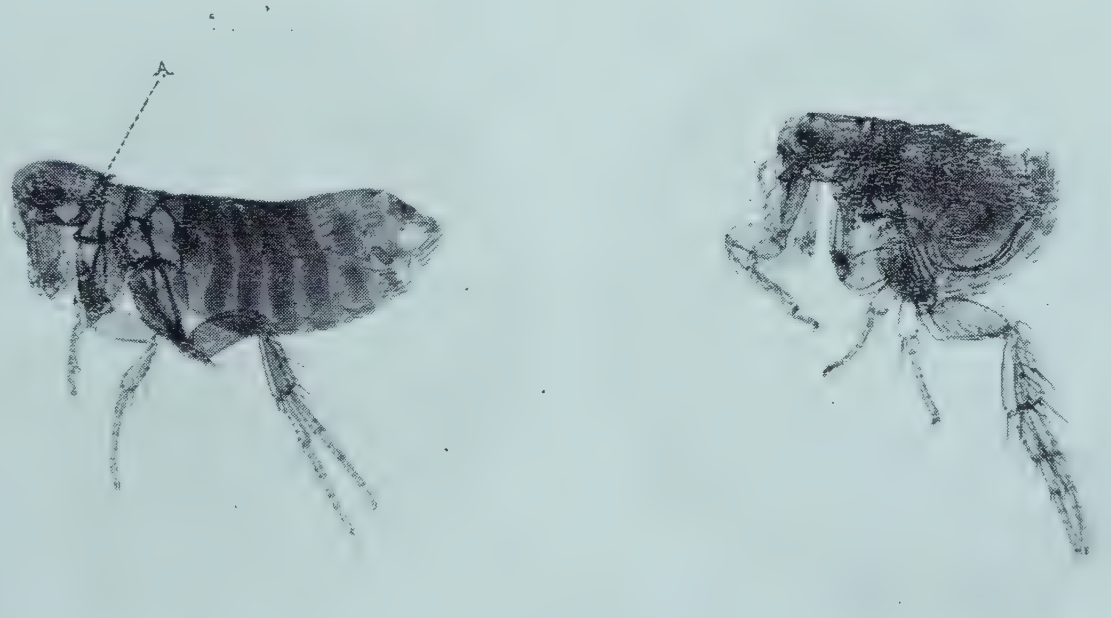
Xenopsylla cheopis (Fig. 182), the combless flea of the Black Rat, is the chief natural vector of plague. Originally an Eastern species it is now world-wide in seaports. Though it specially affects the Black Rat it is found on the Brown Rat also. When Xenopsylla bites a plague-stricken rat its dejecta contain the specific organism a few hours later. If it then bites man the plague-charged dejecta are passed in the act of sucking and may be scratched by the victim into the puncture made by the insect. The flea may die of its attack of plague. If it recovers it may continue effective for a time (Fig. 183 (1)). If the bacillus implants itself among the chitinous bristles of the proventriculus (Fig. 183 (2)) the flea becomes a permanent vector. If the bacterial growth blocks the proventriculus entirely (Fig. 183 (3)) the famishing Xenopsylla bites often and sucks strenuously, distending its oesophagus in vain attempts to clear away the obstruction (Fig. 183 (4)). When its muscles at last relax the blood which it has sucked up regurgitates back into the wound laden with plague bacilli. Xenopsylla also conveys endemic typhus, or Brill's disease, to man.

Ceratophyllus fasciatus (Fig. 182), which bears a comb, is the usual flea of the Brown Rat in temperate climates. If it takes up *B. pestis* from its rodent host it may remain infective for a month or two. As a vector of plague to man it is less formidable than *X. cheopis*.



Pulex irritans ♂.
Ae. genitalia.

Pulex irritans ♀.
Sp. genitalia.



Ceratophyllus fasciatus ♀.
A. comb.

Xenopsylla cheopis ♂.

Fig. 182.—Fleas.

Tunga penetrans is the jigger flea of South America, the West Indies and West and East Africa. The male and the unfertilised female are each 1 mm. long. The fertilised female burrows into the skin of man, usually attacking the toes of the native, and raising swellings which ulcerate and may become septic.

Pulex irritans may be destroyed by sprinkling naphthalene freely ov the floor and ledges of rooms, which are then left closed for 2 day In rooms used by day only, the process may be repeated for 3 nights i succession. Spraying with 3 per cent. lauryl thiocyanate in kerosene i also effective. Or SO_2 gas may be employed, 3 lbs. of sulphur bein burned per 1000 cubic feet of space and 6 hours' exposure give Persons exposed to the risk of infestation can render themselves un attractive to fleas by the use of 10 per cent. D.D.T. in kaolin.

The insects of the Order *Hymenoptera* have biting and licking mouth parts and two pairs of membranous wings. In some families th abdomen of the female is armed with a sting. The *Aculeata*, or stingin hymenoptera, include the *Apidae* or Bees, the *Vespidae* or Wasps, th *Fossores* or Digger-wasps and the *Formicidae* or Ants. The poison o bee and wasp stings produces both local and constitutional effects. Be

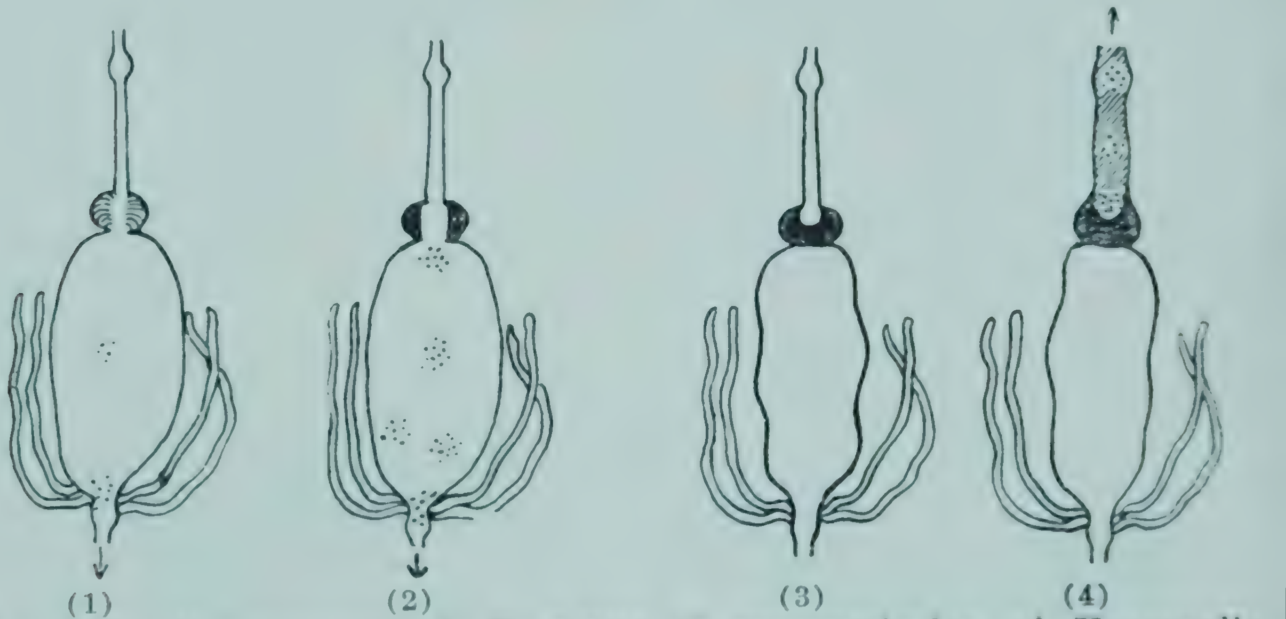


Fig. 183.—Development of *B. pestis* in proventriculus of Xenopsylla.

venom is described as neurotoxic and haemolytic. One sting by a b or wasp about the throat may be dangerous if the swelling obstruc respiration: multiple stings by angry swarms have on occasion prov fatal to man.

A bee or wasp sting should be dealt with in early stages by injectin cocaine hypodermically or by the application of menthol, grs. 30 Tinct. Benzoin. Co. ℥i: later on by the use of a lotion containing lea zinc or alum. Syncope, which supervenes in severe cases, may al require treatment.

The solitary digger-wasps, *Mutilla glossinae* and *M. benefactrix*, a friends to man. Their females oviposit in the pupae of *Glossi morsitans*, which fail in consequence to mature.

Certain kinds of small ants are often troublesome pests in hous hospitals, etc. A common species is the cosmopolitan *Monomori pharaonis*, or Pharaoh's Ant. The workers are light reddish yellow a about 1½ mm. long. Their numbers may be reduced by trapping small pieces of sponge soaked in a sugary solution, but the only me of complete eradication is to locate the nest and destroy the colony.

CLASS ARACHNIDA

The Arachnida differ from the Insects and other classes of Arthropods in being without antennae or true jaws. Excepting the king-crab, which inhabits the sea, they are all terrestrial, breathing air as a rule by means of tracheae or by lung-books. In typical species the head and thorax are fused into a cephalothorax which carries four pairs of legs. The mouth appendages are a pair of chelicerae and a pair of pedipalps. Most Arachnida are oviparous but some are viviparous. Scorpions, spiders, ticks and mites are all Arachnids.

Members of the Order Scorpionida inhabit warm countries. Their pedipalps are large prehensile claws. Their telson is converted into a sting for injecting poison into their prey. Among the effects of the venom on man are local inflammation and muscular paralysis, often attended by shock but usually terminating in recovery.

The Order Araneida, or Spiders, have chelicerae equipped for the discharge of poison. The strength and character of the venom varies with the species. The bite is in some cases highly toxic and may be fatal to man.

The Order Acarina contains the Ticks and Mites. Most members of the order are minute. Many are parasitic on animals. Some are vectors of disease to man. The body is often oval or obscurely circular owing to the fusion of the abdomen with the cephalothorax. The female is oviparous, and metamorphosis occurs. The larva has three pairs of legs: the nymph and the sexually mature adult four pairs. The families of the order which in varying degrees possess medical interest are the Ixodidae, Argasidae, Trombidiidae, Sarcoptidae, Tarsonemidae, Tyroglyphidae and Demodicidae.

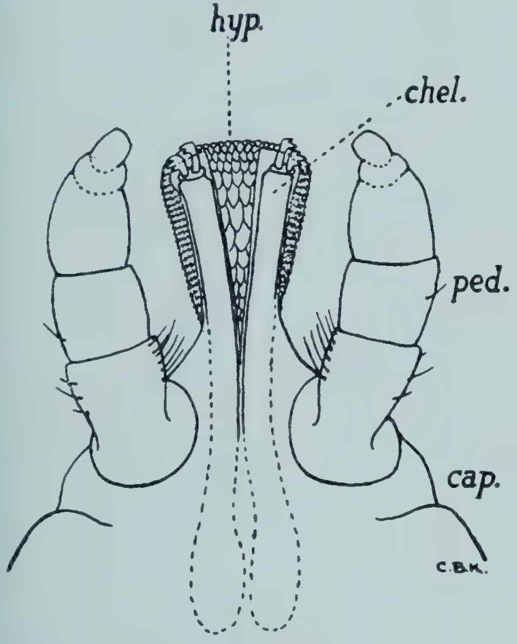


Fig. 184.— Mouth-parts of Tick.

cap., capitulum; *chel.*, chelicerae; *ped.*, pedipalps; *hyp.*, hypostome.

In the Ixodidae or Hard Ticks the body is oval and covered by a chitinous shield. The beak (Fig. 184), which includes a rasp or hypostome besides chelicerae and pedipalps, is visible on a dorsal view. A tick when found sucking should be induced to let go by placing a drop of oil on its body. If torn off suddenly it leaves its mouth-parts in the wound. The larva on hatching from the egg carries in its body a store of yolk on which it can subsist for several months. It lies in grass or brush till it can attach itself to an animal host. When filled with blood it drops off, moults and becomes a nymph without genital pore. The nymph in turn attaches itself to an animal, feeds, drops off, moults and becomes a sexually mature adult. In some species the whole metamorphosis is completed on the original host. The adult *Ixodidae* are fixed parasites, attaching themselves permanently to a vertebrate victim.

Dermatocentor venustus, one of the hard ticks, transmits to man

Rocky Mountain Spotted Fever. The micro-organism is *Ricketts* *rickettsi*. *D. venustus* once invaded by it becomes a permanent vecto and may pass on the infection to its progeny The larva and nymph frequent the groun squirrel, *Citillus columbianus,* and the woo chuck, *Marmota flaviventer.* The natural hosts of the adult, which alone attacks man, are th goat, sheep, brown bear, coyote, badger and wil cat. Preventive measures include the destructio of the ground animals and the dipping of flocks Workers on infested land should wear a one piece suit with tick-proof strapping at th wrists and ankles. *D. venustus* also transmits tularaemia.

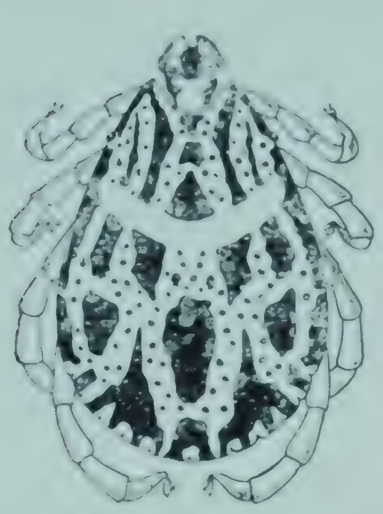


Fig. 185.—Dermatocentor venustus.

Children in North America and Australia when bitten on the head or near the spine by *D. venustus* and certain other ixodids may develop *Tick Fever* which resembles poliomyelitis in its onset, but has no paralytic sequelae. The symtom complex is due to the poison of the bite. No *contagium virum* is concerned. In severe cases there may be convulsions and death may ensue.

Ixodes ricinus, the hard sheep and dog tick of Europe, is believed to convey *Piroplasma bovis* to oxen and the Louping Ill to sheep.

In the family Argasidae or Soft Ticks there is no chitinous shield The body bulges forward over the beak so as to conceal it on a dorsa view. In this particular the soft ticks differ from all other acarin families. The adult Argasidae are not fixed parasites. They hide i chinks and come out to feed on blood.

Argas persicus is the cosmopolitan Fowl Tick. Its venomous bite i painful to man, and when multiple may, either by its toxicity or owin

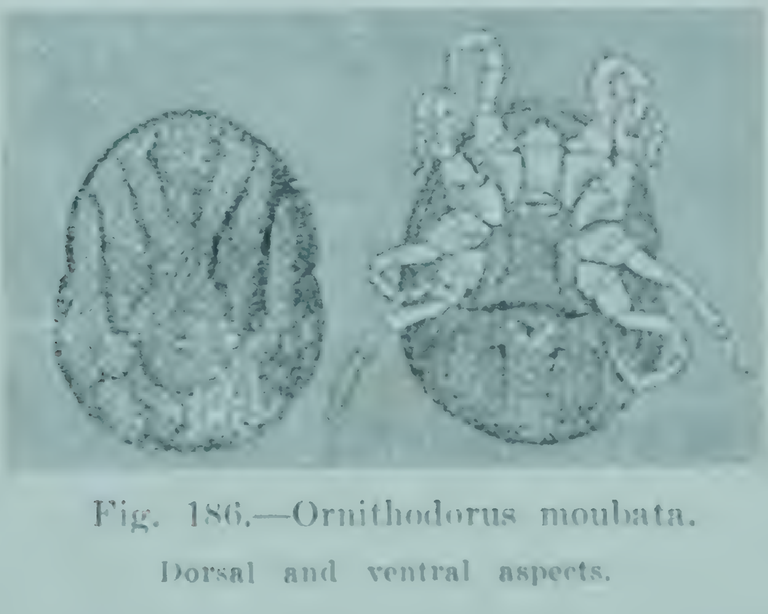


Fig. 186.—Ornithodorus moubata.

Dorsal and ventral aspects.

to the copious haemorrhage induced, be fatal to poultry. *A. persic* has the further demerit of transmitting *Spirochaetosis gallinarum.*

Ornithodorus moubata, another soft tick, is a pest of Africa fro the Transvaal and Angola to Somaliland. It lies concealed by day the walls or floors of huts and rest-houses and emerges at night to suck the blood of sleepers. The bite though not painful at the time causes lasting irritation. *O. moubata* (Fig. 186) is the vector to man of Central African Relapsing Fever, the parasite of which is *Treponema duttoni.* As both males and females bite, both are transmitters. The female hands down the contagium to her progeny.

Ornithodorus savignyi, found in Africa from Lake Chad to Abyssinia and also in India and Arabia, sucks blood by day. Like *O. moubata* it is a natural vector of Central African relapsing fever. Several other species of Ornithodorus are suspected of conveying the disease, either on epidemiological grounds or because they are capable of harbouring the virus under laboratory conditions.

The members of the family Trombidiidae or Velvet Mites are of a bright red hue. Some adults are predaceous: others parasitic on plants or animals. Only the larval forms attack man.

The minute orange-coloured **Leptus autumnalis,** the hexapod larva of a dubious adult possibly *Trombidium holosericeum,* is the 'Harvest Bug' of Britain. The intense itch which it causes may be relieved with a weak lead acetate solution or weak ammonia. The itch producer itself may be killed by the application of petrol or benzine.

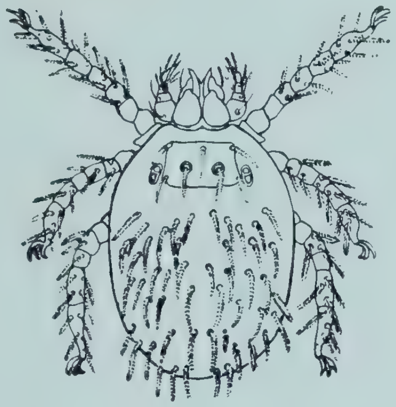


Fig. 187.—Trombicula. akamushi Larva.

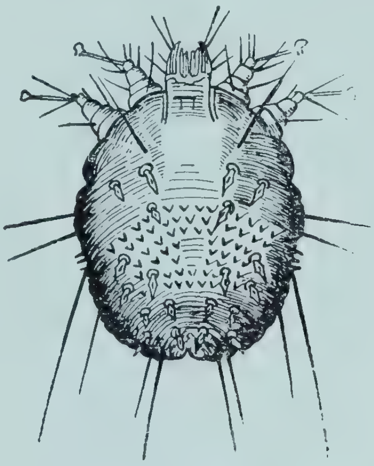


Fig. 188.—Sarcoptes scabiei var. hominis.

Trombicula akamushi is a red mite, the nymph and adult of which live among herbage and do not suck blood. The blood-sucking larva (Fig. 187) is the vector to man of Asiatic Scrub Typhus, formerly Japanese River Fever. The larva is parasitic in Japan on the field mouse *Microtus montebelloi,* in Formosa on the local black rat, though neither rodent appears to contract an infection from its presence. The micro-organism of the fever which it conveys to man may be *Rickettsia orientalis.*

The Family Sarcoptidae includes the Itch, Mange and Scab Mites. They have bodies approximately circular in outline. Their four pairs of stumpy legs, which are arranged in two sets of two pairs each, are attached to the ventral surface by chitinous rods. Some or all of the legs terminate in a sucker.

Sarcoptes scabiei, var. hominis, is the Itch Mite (Fig. 188) which

infests the skin of man in all countries. The male is 0·2 mm. long, th
female 0·4 mm. Both have stalked suckers on some of their stumpy leg
The fertilised and fully mature female lays forty to fifty eggs in
burrow in the skin over which the male keeps watch. Hatching in a fe
days the egg releases the hexapod larva which makes its way to the ski
surface, moults several times, and is so transformed into the octopo
nymph. The nymph moults again and becomes sexually competen
though not yet fully mature. The nymphs pair, and after pairing th
young fertilised female strays for a week about the skin. After a fina
moult she is fully mature, having developed the tokostome or birth pore
She now makes her burrow into the skin, depositing her clutch of eggs a

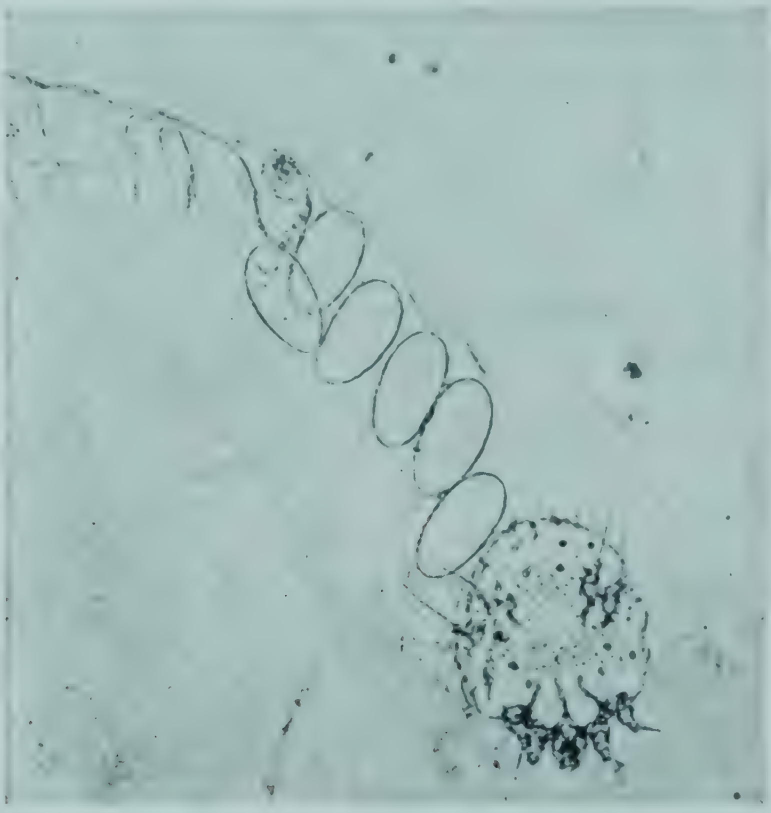


Fig. 189.—Sarcoptes scabiei.
Dissection of burrow showing female and ova.

she advances, and dies in a month at the end of her burrow (Fig. 189
In mild cases of itch the burrows may be noted between the fingers an
on the wrists, their position being marked by minute vesicles produced b
irritant secretions of the mite. In severe cases, as a result of scratchin
and consequent secondary infection, there may be widespread pustula
tion and crusting (Fig. 190). The head however is always free an
the neck and back nearly always. The itching is usually worst in be
Itch is most likely to be caught by occupying the same bed as a scabiet
patient. Venereal contact may convey the disease. Fomites are unlike
to harbour the mite. The infective agents are the young fertilise
females, which in their wanderings change hosts, and when fully matu
invade the skin of the new victim. Mellanby considers that infection m
be present for some time before the characteristic itching is establishe
He believes, moreover, that a true sensitisation to the disease may resu
from the infestation. The lack of washing and the use of blankets
common are favourable to the spread of itch. The Norwegian it
affects the whole body surface, including the scalp and the finger nail

The treatment of scabies should begin with a hot bath, followed by thorough drying. A 20 per cent. emulsion of benzyl benzoate, consisting of equal parts of benzyl benzoate, methylated spirit and soft soap, should next be painted over the whole body, using an ordinary flat paint brush, and allowed to dry in warm air. The same underwear should then be put on again and worn for 24 hours, after which the patient should have another hot bath and then don clean underwear. It will be sufficient treatment for the outer garments to press them with a hot iron. Approximately one and a half ounces of benzyl benzoate emulsion are sufficient for an adult. The method is comparatively painless and a single application suffices for cure in 90 per cent. of the cases. When combined with stearic acid and triethanolamine, benzyl benzoate is painless even in infants. Soapy solutions of derris root, as well as emulsions of its active principle, rotenone, are recommended by some, but are less effective than benzyl benzoate. Rotenone may furthermore cause dermatitis. In the Danish polysulphide ointment for itch, Unguentum Hepatis Sulphuris Marcussen, the active ingredient is Potassium pentasulphide K_2S_5, aided by Potassium thiosulphate, $K_2S_2O_3$. Kathiolan is a similar compound. The ointment is applied after a bath: then the patient stays in bed for 24 hours, after which another bath is taken.

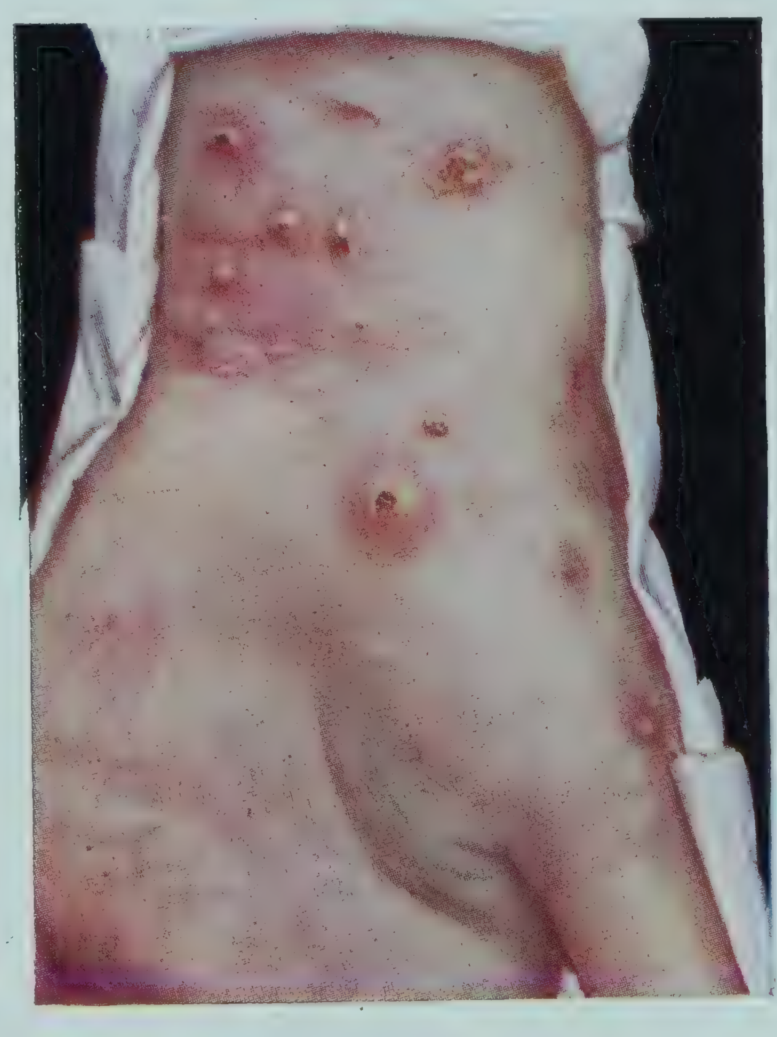


Fig 190.—Scabies.

In terms of the Scabies Order, 1941, a medical officer of health, after sundry procedure, if satisfied by his own examination or by a medical certificate that a person is scabietic and requires cleansing and treatment may by written notice require the person to present himself within a specified period at a specified place and submit himself to the cleansing and treatment there provided.

Sarcoptic mange of animals may on occasion be passed on to grooms, cattlemen, dog fanciers and others, but the attack, though sometimes sharp, is usually transient in itself or soon yields to remedial measures. Psoroptic mange, due to species of *Psoroptes*, is exemplified by sheep scab. Chorioptic mange is the result of infestation by *Chorioptes*, a sarcoptid which feeds on epidermal scales but neither punctures nor burrows. All domestic animals but the pig are subject. It is responsible for Itchy Leg in draught horses and for one form of Dairyman's itch.

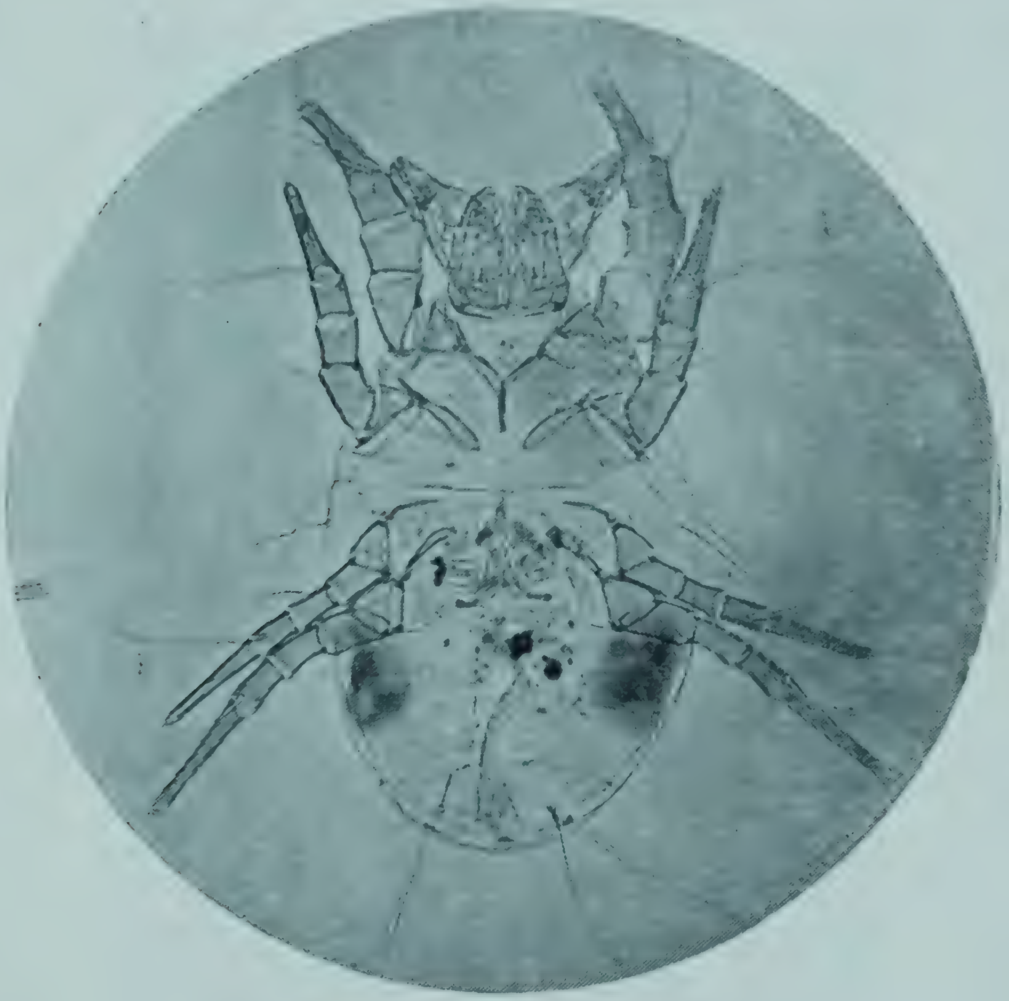


Fig. 191.—Aleurobius farinae.

The family Tyroglyphidae, which feed on dried provisions and groceries, have usually a distinct cephalothorax. *Tyroglyphus dimidiatus*, or *T. siro*, is the cheese mite, common in cheese and other foodstuffs. *Glyciphagus domesticus* is the sugar, or furniture, mite, one causative agent of Grocer's Itch. *Tyroglyphus*, or *Aleurobius farinae* (Fig. 191), the flour mite, which lives in flour, custard powder, breakfast cereals and the like, may also set up an itching eruption. Tyroglyphid eggs, when swallowed in food in sufficient numbers, are capable of producing intestinal irritation. The control of the insect and arachnid pests of foodstuffs has already been discussed.[1] Regular firing of rooms is prophylactic of the furniture mite, which is most frequent in late autumn and early spring. Glyciphagus may breed in furniture stuffing, especially when Algerian fibre is present. Severe infestations may render a re-stuffing of the furniture necessary.

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[1] Page 550.

CONTACT INSECTICIDES.

The most satisfactory results in the control of insect pests are obtained from substances which act by contact, and are persistent. Noteworthy among the newer compounds which possess these properties are 'D.D.T.' (dichloro-diphenyl-trichlorethane), the related 'T.D.E.' (chlorphenyl-dichlorethane) and 'Gammexane' which is the gamma isomer of Hexachlorocyclohexane, lately developed by Imperial Chemical Industries.

Dichloro-diphenyl-trichlorethane was first patented by the Swiss firm of Geigy in 1940. The chemical is a crystalline white solid, insoluble in water, but soluble in a variety of organic compounds, including paraffin, benzene and carbon tetrachloride. Commercial D.D.T. contains up to 80 per cent. of the pure substance. It is relatively non-toxic to mammals but is fatal to most insects. The lethal time varies with the different genera. Mosquitos and house flies, for example, are killed in a few minutes, lice usually take several hours to die, while cockroaches and bed bugs may live for two days after contact with the preparation. D.D.T. may be employed in powder form, or as a spray. As a powder it has a particular value as a disinfesting agent in times of typhus prevalence. Thus, in the epidemic at Naples during the Second World War, 73,000 persons were disinfested by the 'blower' method[1] in a single day. In the form of a paraffin emulsion sprayed on walls and ceilings, D.D.T. is an effective repressant of muscid and other flies, and mosquitos. The compound is lethal also to fleas. D.D.T. is possibly toxic for man, especially in supersensitive subjects, due most probably to the impurities present in its commercial forms. Laboratory experiment suggests that anorexia is most likely to be the warning sign of the toxic effect. For practical purposes, however, the low concentrations of the chemical employed in disinfestation may be regarded as harmless.

'Gammexane,' like D.D.T., than which in certain instances it is more potent, is of low toxicity for mammals, though actively insecticidal in high dilutions. The compound is effective against a wide range of arthropods, including the cockroach, louse, mosquito and house fly, and the parasites of stored foods. It is efficacious also in the case of mites and ticks. The product is available in a variety of forms. Gammexane *Dust,* coded D.034, is particularly suited to outdoor use, including the control of breeding both in house flies and in mosquitos. Table 41, which is reproduced by courtesy of Imperial Chemical Industries, exhibits its effect in the case of mosquitos. Mixed with an inert vehicle, such as gypsum or china clay, in proportions to give a concentration of 0·015 per cent. by weight of gammexane, the dust satisfactorily eradicates *Calandra* and other parasites in stored cereals. Grain so treated is safe for human and animal consumption without reconditioning. Gammexane *Spray*, coded L.044, contain 0·35 per cent. of the isomer, and is ready for use as purchased. I is markedly persistent on walls and flooring and is therefore of valu for the indoor control of houseflies, mosquitos and moths. In granarie and food stores the spray is actively parasiticidal. A liqui 'Gammexane' concentrate, coded LG.140, is also procurabl 'Gammexane' *Smoke* is readily produced from a special generator The cyclohexane-laden fumes act first as a fumigant and later depos

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[1] Page 541.

TABLE 41.

Toxicity of Various Insecticides to the Larvae of *Aedes aegypti.*
(F. J. D. Thomas)

Insecticide	lb./acre	Per cent. Larvae Dead		
		After 1 day	After 2 days	After 3 day
Crude benzene hexachloride . . .	0·5 0·06	0 0	23 0	93 20
'Gammexane' . .	0·5 0·06	0 0	97 33	100 80
Cuprous cyanide . .	0·5 0·06	47 30	73 40	87 65
D.D.T.	0·5 0·06	0 0	43 23	97 47
Carrier dust only .	10 0	0	0	·13

a persistent film of the insecticide upon exposed surfaces. The generato offer no risk of fire, since they produce neither flame nor incandescen The smoke method lends itself to the disinfestation of houses, publ transport vehicles and ships The generator is ignited by means of match and then placed upon, say, a shovel, when it will liberate i total volume of insecticidal smoke within two minutes.

LABORATORY DIAGNOSIS OF PARASITES

The Regulations which govern the transmission of pathologic specimens by post apply also to parasitological material. When su material is sent to a laboratory for identification, precautions shou be taken to preserve as far as possible the morphological and oth characteristics upon which identification may rest. The notes whi follow are intended as a guide to procedure in the case of parasit ordinarily encountered.

Helminthes. If living material has to be kept some time before examination it should be put in a cool place or even in a refrigerator. If it is kept warm it will perhaps be more active for a time, but degeneration sets in sooner. An examination of the living material should be made when possible; it is sometimes more informative than after fixation, and in some cases is all that is necessary for diagnosis.

Before fixation, worms should be washed in saline to remove adherent mucus which might obscure their structure at some later stage. As a safe fixative for general purposes 5 per cent. formalin in saline may be used, and the material may be transmitted to the laboratory in this fluid. In the case of the Platyhelminthes, which are extremely contractile, it is important to take measures to ensure the greatest degree of expansion possible.

Trematodes should if possible be killed in a saturated aqueous solution of corrosive sublimate to which has been added 5 per cent. of glacial acetic acid. Before the mixture is poured on, the fluke should be pressed under a glass slide which will flatten it sufficiently, and when it becomes opaque the slide should be removed so as to let the fixative act freely on the worm. The appropriate duration of immersion in the fixative depends on the thickness of the worm. A large fluke such as *Fasciola hepatica* should have at least half an hour.

Cestodes will die in an extended state if left in water. As soon as they become motionless they should be fixed, or maceration will set in. For diagnosis or storage they may be fixed in 5 per cent. formalin in saline. In larval forms the head is preferably evaginated in warm water before fixation.

Nematodes if large (*e.g. Ascaris*), are well fixed in a 5 per cent. formalin in saline; if small (*e.g. Enterobius*), fixation is better in 70 per cent. alcohol, preferably hot. The worms may be sent in the mixture used for fixation. In blood or lymph larval Nematodes may be sought in fresh thick or thin films.

Eggs of worms are diagnosed in the fresh state. Material containing them may be preserved by adding an equal volume of 10 per cent. formalin in saline and stirring well.

Eggs are usually detected, *e.g.* in faecal material, by working over a fairly thick film in saline, under a cover slip, with a suitable combination of lenses and preferably with a mechanical stage.

It must always be remembered that the finding in dejecta of some organism does not necessarily indicate that it is living parasitically in the body of the patient. For example, faeces, especially if they are not quite fresh, may contain non-parasitic forms which develop in faecal material outside the body. Resistant stages may also be recognisable in the faeces after passing through the entire alimentary canal; for example, eggs of liver flukes eaten in infected liver. Such occasions are probably rare, but the possibility should be borne in mind.

Arthropoda. Several specimens of the insect or arachnid to be identified should wherever possible be sent. In the case of winged insects, a proportion of the specimens should be placed in a flat-bottomed glass tube, killed by adding a few drops of ether, and transmitted to the laboratory in the dry state. The rest should be sent in 70 per cent. alcohol, which serves also for wingless insects, and arachnids, and for larval and other stages. Where food parasites are concerned, they should not be removed from the commodity in which they are present; but a sample of the food, with the parasites *in situ,* should be sent in a sealed tube or jar. There is an exception to this rule in the case of food-infesting moths, which should be separated from their nidus and forwarded dry in specimen tubes.

When there is doubt as to the laboratory to which parasites should be sent for identification, the advice of the Medical Officer of Health should be sought. Opinions regarding food parasites may be obtained from the Infestation Officers of the Ministry of Agriculture and Fisheries; or, in Scotland, of the Department of Agriculture.

Filthy or Verminous States

Premises. Under the Public Health Act, 1936, where it appears to a local authority, on an official certificate, that any dwelling-place i filthy or verminous they may call upon the owner or occupier to cleanse the premises or destroy the vermin. If he fails to comply he is liable to fine and the local authority may themselves do what is required and recover expenses. Under prescribed conditions the local authority may use gas as the insecticide, providing shelter for any person temporarily displaced.

Articles. Equivalent provisions apply to filthy or verminous articles.

Persons. On the application of a verminous person a local authority may take steps to free him and his clothing from vermin. Where it appears to a local authority, on an official report, that a person or his clothing is verminous they may, if he consents, remove him to a cleansing station, which the local authority are authorised to provide, and there take steps to free him and his clothing from vermin, no charge being made for the service, and the cleansing of females being carried out only by a registered medical practitioner or a woman authorised by the medical officer of health.

If the person does not consent, the local authority may apply to a court of summary jurisdiction, and the court, if satisfied, may order his removal to the station and detention there till cleansed.

Consent in the case of a person under 16 may be given by a parent or guardian.

School Children. Under section 54 of the Education Act, 1944, a local education authority may authorise a medical officer of theirs to cause examinations of the persons and clothing of pupils attending schools maintained by them or otherwise specified, whenever in his opinion such examinations are necessary in the interests of cleanliness. In the case of a county college a corresponding examination may be made, if a medical officer has reasonable cause to suspect that the person or clothing of a pupil in attendance is infested with vermin or in a foul condition.

Such examinations may be made only by a person authorised for the purpose by the education authority, and if the person or clothing of any pupil is found to be infested with vermin or in a foul condition any officer of the authority may serve on the parent, or in the case of county college on the pupil, a notice requiring the person and clothin of the pupil to be cleansed.

This notice should inform the person upon whom it is served that unless within a stated period the body and clothing of the pupil ar cleansed to the satisfaction of the person specified in the notice, th cleansing will be due to be carried out under arrangements made b the education authority. If on the expiration of the stated period medical officer of the authority is not satisfied that the person an clothing of the pupil have been properly cleansed he may issue 'cleansing order' directing that the person and clothing of the pup be cleansed under the arrangements above mentioned.

It is the duty of the education authority to secure that any perso or clothing required to be cleansed may be dealt with at suitable premises by suitable persons and with suitable appliances and, where the council of the local county district are entitled to the use of premises or appliances for cleansing the person and clothing, the authority may require the council to permit them to use these premises or appliances on such terms as may be determined by agreement.

The 'cleansing order' by a medical officer referred to above is sufficient to authorise any officer of the authority to cause the person and clothing of the pupil concerned to be cleansed according to arrangements and for that purpose to convey him to, and detain him at, the premises provided.

If, after the cleansing of the person or clothing of any pupil has been carried out, his person or clothing is again found to be infested or in a foul condition at any time while he is in attendance at a school maintained by a local education authority or at a county college, and it is proved that the condition of his person or clothing is due to neglect on the part of his parent or in the case of a county college to his own neglect, the parent or the pupil, as the case may be, is liable on summary conviction to a fine up to 20 shillings.

In Scotland the fines are, for the first conviction up to £1, for the second conviction up to £5, and in the case of a third or subsequent conviction a fine up to £10 or imprisonment up to a month, or both fine and imprisonment.

Where a medical officer of an education authority suspects that the person or clothing of any pupil in attendance at a school maintained by the authority or at a county college is infested with vermin or in a foul condition but action for examination or cleansing cannot immediately be taken he may, if he thinks it necessary, direct that the pupil be excluded from the school or college until such action is taken.

No girl may be examined or cleansed except by a duly qualified medical practitioner or by a woman authorised for that purpose by a local education authority.

In Scotland the procedure for filthy *premises* and *articles* under the Public Health (Scotland) Act, 1897, is on the same lines as above. For *verminous persons* in Scotland it is laid down in the Cleansing of Persons Act, 1897, that they may, on application, have the use free of charge of any cleansing apparatus which the local authority possesses. The local authority are authorised to provide a cleansing station, but no power is given under the Act to compel verminous persons to undergo cleansing. For *school children* the procedure in Scotland under the Education (Scotland) Act, 1945, is the same as in England and Wales under the Education Act, 1944.

RATS AND MICE

Rattus rattus, called the Ship or Black Rat (Fig. 192), though most are brown, is neat and rather slender. Its ears are translucent and large, reaching or covering the prominent eyes when pressed forward. Its tail is at least equal to the combined length of its head and body. Being by nature a climbing rodent the black rat frequents the superstructure of houses. It is a clean feeder, seeking to share the grain and other food

of man. Though not attracted by water it is the usual rat of ship
and may abound in seaports.

Rattus norvegicus, called the Brown Rat (Fig. 193) though many ar
black, is the common rat of Britain. It is larger and of heavier buil

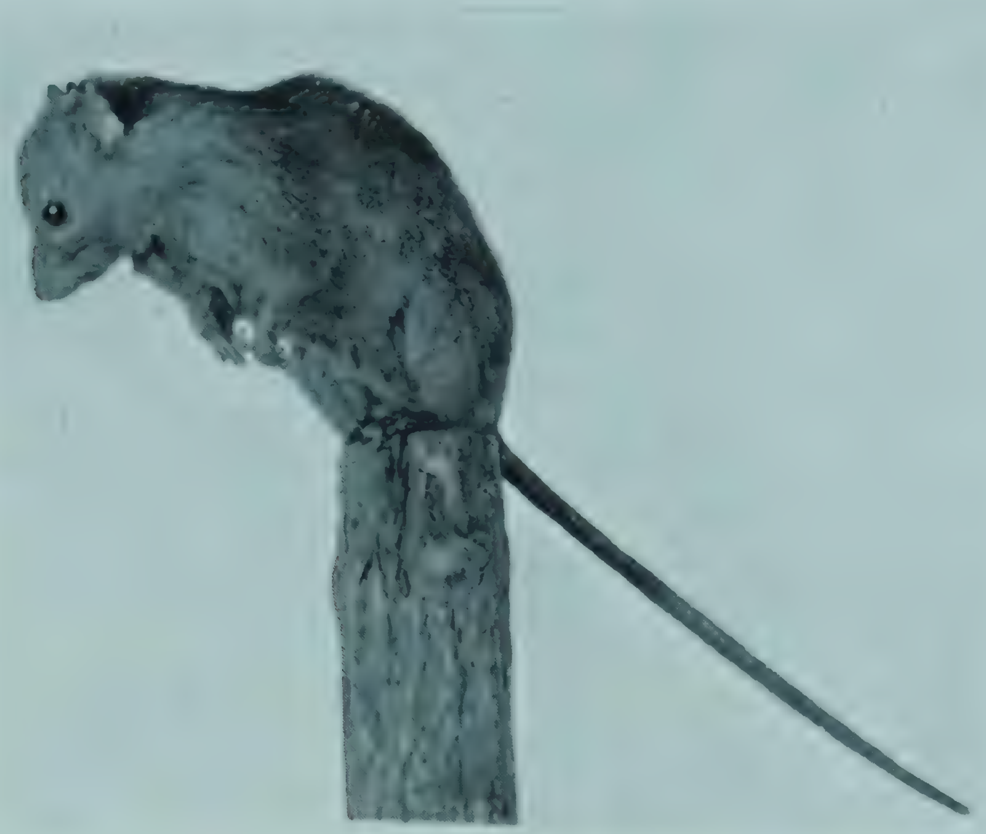

Fig. 192.—Black Rat.

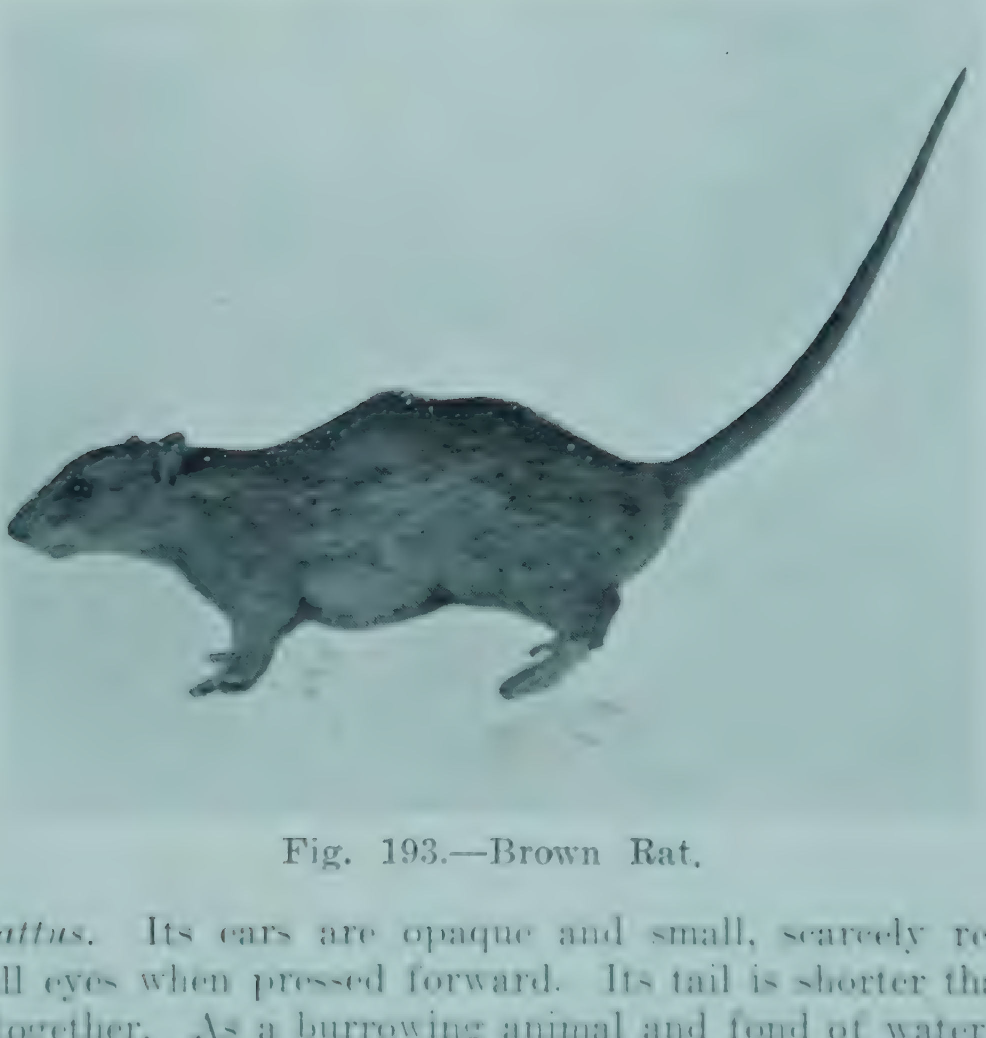

Fig. 193.—Brown Rat.

than *R. rattus*. Its ears are opaque and small, scarcely reaching th
rather small eyes when pressed forward. Its tail is shorter than its hea
and body together. As a burrowing animal and fond of water the brow
rat frequents the banks of streams or infests drains and sewers, fro
the last of which, being unfastidious, it may also derive its food. I

finds its way from drains into the basements of houses. Rats establish burrows in hay stacks and municipal refuse tips. Others live in coal mines. Many move out in spring from buildings to pass the summer in the open fields and return in autumn to the haunts of men. Rat migration is determined also by variations in the food supply.

Rats are extremely prolific and are sexually mature at the age of three months. The female of *Rattus norvegicus* may produce up to 14 young at a single litter, repeating the process every six weeks during the breeding season which lasts from March until August. *R. rattus* has fewer young at a litter but is nevertheless a rapid breeder. The fecundity of rats is to some extent balanced by the high mortality amongst their young.

Rat Infections. *Plague* is normally an enzootic of rats. When it becomes epizootic man is in danger. The view is held that the risk is greater from the house-haunting Black Rat with its flea, *Xenopsylla cheopis,* which becomes a permanent vector, than from the burrowing Brown Rat, which does not frequent houses, or its flea, *Ceratophyllus fasciatus,* which if it takes up *B. pestis* remains infective only for a limited period. Endemic typhus or Brill's disease is an enzootic of rats which is conveyed to man by *X. cheopis.* Salmonella infections occur in the rat, the commonest strain being *B. enteritidis* (Gärtner). Prepared meats and similar foods contaminated by the excreta of infected animals produce in man bacterial food poisoning. Spirochaetosis is a disease of rats occasioned by *Leptospira icterohaemorrhagiae.* Infected rats excrete the contagium in the urine and faeces. In coal mines water thus contaminated conveys the disease to man. Trichiniasis, as already noted, affects man, the pig and the rat, which last may be the reservoir host. Rat-Bite Fever ensues upon the inoculation of man with the infective agent Spirillum minus, othewise *Treponema morsus murium.*

Other Damage. Rats undermine the foundations of buildings. In their continual gnawing to control the growth of their incisors they damage doors, joists and other woodwork in houses, perforate leaden gas and water pipes and strip the insulating cover from electric wires. They attack textiles and similar fabrics in order to obtain nesting materials. In ships, docks and warehouses they consume or destroy goods of all kinds. The brown rat is a bane to agriculture, consuming grain freely as well as root crops, fruit and vegetables. It also kills young game and poultry, and causes heavy losses to breeders by taking the food intended for their stock. The number of rats in Britain has been estimated as one per head of the human population.

Rat Control. Foodstuffs in warehouses should be kept in rat-proof metal containers or under wire-gauze covers. Ashbins should be of metal and should have close-fitting lids. Accumulations of refuse round houses should not be permitted to occur. Buildings should be erected on concrete foundations, and walls in basements rendered in cement. Necessary openings, such as windows in basements and fresh-air inlets for drains, should be guarded with wire gauze. Ricks or chicken houses at farms should be set on platforms raised clear above the ground.

Systematic poisoning is best employed when food supplies tend to be short as in the month of March. Its aim should be to kill as many rats as possible within a short period, say, three weeks. The poisons most likely to be effective are arsenic, zinc phosphide, barium carbonate sold commercially as 'witherite,' and red squill. The last is harmless to domestic animals and to poultry. Poison-free token baits of sausage, rusk, bread, porridge, kibbled wheat or whole meal should first be laid down, preferably near the burrows, in order to accustom the rats to the food. After several days the token baits should be replaced by those containing the selected poison. A concentration in the bait of 20 per cent. arsenic, 5 per cent. zinc phosphide, 20 per cent. barium carbonate or 10 per cent. red squill is sufficient.

Fumigation of burrows gives good results. Sulphur dioxide gas may be liberated into a bolt hole or carbonic oxide delivered from the exhaust of a petrol engine. Hydrocyanic acid gas is potent but owing to its attendant risks to fumigators and others must be administered with caution. Cyanogas blown into the burrows is fractionally less dangerous than HCN. The fumigation of ships for rats is described below.[1]

Viruses so-called, which are designed to initiate a rat epizootic, have been found capricious in action and may by inadvertence infect children. A large proportion of the rats may moreover prove immune to the bacterial strain employed. On this account certain manufacturers offer two preparations. One is the microbic culture; the other a chemical poison to kill rats unaffected by the bacteria. The Danysz virus is a culture of *B. typhi murium*. 'Ratin' and 'Liverpool Virus' are similar preparations.

Trapping should be regularly carried on and intensified once a year during 'rat week.' Steel spring traps are best, but wire traps may be used.

Rat drives with terriers and ferrets may be got up on a combined or intensive plan, especially in rat week.

Mus musculus, the House Mouse, is of slender build like the Black Rat and about one-third of its size. Mice are mature at 3 months and have several litters per year, each averaging five young. A few mice in a house may be more or less innocuous, but if infected, as they may be, with *B. aertryck* they are apt to contaminate such foods as cream confectionery and so originate bacterial food poisoning in consumers. In a house invaded by mice in force there is extensive destruction of woodwork and fabrics together with loss and pollution of food. In large-scale mouse plagues, extending over a county or two, voles and other types share and continue to over-propagate until a timely epizootic brings their numbers back to normal. With a view to the repression of mice about houses all food should be kept in metal containers, waste food should be promptly removed from the premises and mouse holes should be filled up with cement or gas tar. Direct measures include the use of cats, and of spring traps usually baited with cheese. Owls and weasels by preying on mice in the open render good service to agriculture.

The Rats and Mice (Destruction) Act of 1919 applies to both England and Wales and Scotland. Any person who does not take steps to destroy rats and mice on his land is subject to fine. The Rats and Mice (Scotland) Order, 1943, charges local authorities with the control of rodent infestation and may compel owners or occupiers of infested premises to take necessary action.

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[1] Page 643.

PATHOGENIC FUNGI

The principal fungi pathogenic to man include the following genera :—

Trichophyton. This parasite is responsible for ringworm of the scalp and beard, and of the glabrous skin as in 'athlete's foot.' The mycelium attacks the medullae of the affected hairs. These are broken off at epidermis level, producing the typical 'black dot' effect. *T. crateriforme* is most commonly implicated in scalp ringworm. Kindred species in lower animals are transmissible to man. Trichophyton affections of the foot respond readily to Whitfield's salicylic ointment. Shoes should be disinfected with weak formalin, and cotton socks worn during treatment.

Microsporon produces ringworm of the scalp, and rarely of the body, in young children. It is not found after puberty. The mycelium produces a tracery of minute spherical spores on the external aspects of the hairs. Clinically the disease shows as a pinkish scaly patch, on which broken hairs are seen. *M. audouini* is the species commonly found in children. *M. furfur* causes pityriasis versicolor. Other species which occur in animals may parasitise man. Microsporon ringworm has recently shown some prevalence in Scotland, over 300 cases being recorded in one Lanarkshire burgh.

In diagnosis, the affected hairs or epithelial cells should first be cleared by warming on a slide with 10 per cent. K.O.H. A cover slip is then applied and the preparation is examined unstained with the $\frac{1}{6}$-in. objective. A rapid method of diagnosis, suitable for reviewing large numbers of children, is by irradiation of the ointment-free scalp with ultra-violet light filtered through a Wood's nickel oxide-glass screen, when the affected hairs will fluoresce characteristically green. The x-ray and thallium acetate, in combination with appropriate antiseptic unguents, have given excellent results in treatment but should be employed only by experts. Thirty days' exclusion from school of infected children is generally sufficient. The possibility that the infective source is a pre-school child in the household should be kept in mind. In the Scottish outbreak referred to, co-operation of the press, teachers and parents, together with the inauguration of a special treatment centre brought the disease under control within three months.

Achorion. *A. schönleinii* causes favus of the scalp or skin. The mycelium and spores are disposed round the hair follicles, producing characteristic yellow discs (scutula) and affecting also the hairs themselves. The x-ray and copper sulphate ointment are of value in treatment.

Blastomycetes. These, the yeasts, reproduce by gemmation. *Monilia candida,* formerly *Oidium albicans,* the causal agent of thrush, has elongated cells resembling hyphae.

XXI.

PERSONAL HYGIENE

THE health services of communities, which have been discussed in previous sections, safeguard the welfare of the individual in important respects. They secure the purity of the water he drinks and of the food which he consumes, regulate the conditions under which he is housed and protect him from the risks of his calling. In various ways they provide him with a defence against many communicable diseases. Furthermore his birth, infancy and childhood are all supervised and, when he becomes employed, a national insurance scheme offers him treatment in sickness. Sheltered thus from numerous ills, he is a free agent within the law to live his life as he chooses, but he owes it to both himself and the community that he should on his own part seek so to sustain and develop his native powers as to fit him for the efficient discharge of his duties as a citizen. In this endeavour he cannot wholly succeed without the practice of personal hygiene.

While the principles of personal hygiene are fundamentally the same for all, its practice must be permitted to vary within wide limits, having regard to age and sex, constitution and physique, occupation and other modifying factors. The code is not rigid and need not be elaborate. It is still concerned with simple matters as when the world was young.

Use of Air. It is good to camp out in the open air when season and weather permit or, if not, to take the air as opportunity offers. The cool dry air under the sky is better than that of crowded dwellings. The loss of heat which it induces from the skin stimulates metabolism, keys up the vital forces and creates a healthful inclination towards active exercise. The breezes refresh the body even in the absence of sunlight, but a breezy day with bright sunshine, which is rich in the penetrating rays, can produce, especially in the young, a pervasive sense of gladness.

Use of Water. Personal cleanliness is a *sine qua non* of social life but besides making an appeal to the sense of propriety it enables the skin more fitly to discharge its essential functions and prevents the transmission of certain parasitic diseases. The value of soap in washing is to emulsify the skin oils and render cleansing easier. Cheap toilet soaps which contain excess alkali should be avoided. Superfatted soaps should be employed by those whose skins are sensitive. A warm bath at 90° to 100° F. should be taken at bedtime twice a week or oftener. It is no virtue in a healthy person to lie soaking in it for long, unless after hard exercise, when it relieves fatigue. A cold bath at 50° to 60 F., unless found to be followed by a sense of chill, should be taken daily the first thing in the morning by all but the sick, the very young and the very old. By maintaining the activity of the skin-responses t sudden falls of temperature it arms its votaries against the chills which may be contracted by persons passing direct from overheated rooms into the open air. For the purpose of the cold bath a shower is as good as a plunge bath and occupies less floor space. Sea bathing, with swimming, is stimulating to healthy persons, provided that in these latitudes they do not stay more than 15 minutes or so in the water. It is desirable not to bathe within 1½ hours after a meal. Cardiac affections are contra-indicative of sea bathing. Persons suffering from ear conditions should wear a protective rubber cap, or ear plugs, before entering the water.

Discretion in Diet has been an article of medical faith from the earliest times. That there should be a call for the exercise of discretion is owing to the circumstance that, while thirst is a sign of the need of the body for water, the appetite may often be a false guide to the need for food, prompting a person to partake, or to continue partaking, of tempting viands to an extent beyond his physiological requirements. Gluttony, which is the converse of discretion, was accounted one of the Seven Mortal Sins. It may on occasion bring on its own immediate punishment in the pains of surfeit, but, short of obvious excess, habitual high feeding does not appear to be essentially injurious. Dieting to keep down the weight may be regarded as an example of discretion, unless carried to dangerous extremes. For the generality moderation is seemly and judicious.

The number of meals which a person takes, the manner of their serving and their relative importance in the day are normally fixed for him by the customs of the country in which he lives, and regularity in the timing of meals is in general strongly favoured by household managers. For the infant, the child and the adolescent, in whom growth is in active progress, meals should be at regular hours and ample rest provided. Similar arrangements during adult existence are greatly to be commended, but for persons leading strenuous lives often difficult of attainment.

Alcohol is a food and a narcotic. Its food value is strictly limited. It can replace an equivalent amount of carbohydrate or fat and economise protein, but it cannot be stored in the body or utilised for repair. As a narcotic it suspends function by way of the nerve synapses. This effect is most important in the initial stages of the narcosis when skill and judgment may both be impaired without the fact being recognisable till some disastrous accident makes it plain.

Alcohol relaxes the arterioles which carry blood to the skin: hence surface flushing and an agreeable feeling of warmth. In persons exposed to cold this effect is dangerous, since the rate of heat loss is accelerated and the deep temperature falls. If however the alcohol is given after exposure to great cold, when the person has been brought, say, into a warm room, the surface flushing then quickens the heat intake of the body and promotes recovery.

A little alcohol may on occasion aid digestion or induce sleep. It has been of service also in the course of some specific fevers. There is however no evidence that it protects against infection, and its prolonged use in massive doses, as in chronic alcoholism, has a devitalising action upon the tissues, the signs of which may range from some impairment of function to gross degenerative lesions. As regards its prolonged use in moderation there is little to be urged against it in individual cases, but, viewing the question more widely, it may be noted that certain Insurance Companies consider abstainers better lives than non-abstainers and lighten their premiums accordingly.

Alcohol cannot be regarded as a necessary of life. It is in no way an aid to work, whether mental or physical, or a stimulus to efficiency. Strictly moderate doses at adequate intervals can probably be taken by normal people without substantial risk: but the drug effect is operative early and the range of safety narrow.

Tobacco. The specific action of tobacco smoke is due to the alkaloid nicotine, which acts as a nerve sedative. The remaining constituents of the smoke, which are combustion products, are carbonic oxide, pyridine, ammonia and furfurol. CO may attain to measurable concentrations in the blood of cigarette smokers who inhale, and may on occasion show itself mildly toxic. Pyridine, ammonia and the aldehyde furfurol have irritant properties. The first attempt to enjoy tobacco, when made in childhood, induces sickness and collapse, but tolerance in varying degrees is soon established. Among the minor disabilities ascribed to smoking are cardiac arrhythmia, conjunctivitis and pharyngitis. Anginoid effects too have been recorded owing to the constriction of the coronary arteries induced by nicotine. There is however no evidence that smoking plays a significant part in aggravating arterio-sclerosis, nor do statistics suggest that it is attended by any abnormal frequency of lip cancer. The most important lesion associated with smoking is tobacco amblyopia, which in a large recorded series was found to have an incidence of 1 per cent. Most of the sufferers had consumed from 2 to 4 ounces weekly. Often the attack appeared to have been precipitated by some accident or cause of anxiety. Prognosis however was in general good. Unpromising cases were those of a severe type, showing pallor of the optic discs and suffering in addition from feeble health.

The practice of smoking should be restricted to adult ages. It is injurious to boys and girls, and not beneficial to adolescents. Expectant and nursing mothers should smoke only in moderation.

Clothing. The warmth of clothing materials depends upon the quantity of air which they imprison among their fibres. Wool, which contains 90 per cent. of air, is recognised to be warm, and owing to its elasticity still holds much of its air enmeshed even under moist conditions. Hence it does not cling to the skin when wet, which is a merit, since it protects the body from loss of heat by direct evaporation. Irritation of the skin by the saw-edged wool fibres may be prevented by incorporating in the fabric 25 per cent. of cotton or silk. Ordinary cotton and linen hold only 50 per cent. of air. In warm weather they are cool to wear, but if wetted they adhere to the skin. As the moisture with which they are charged evaporates, the latent heat of vaporisation is withdrawn direct from the body, so inducing chill.

While moderate breezes are refreshing inasmuch as they replace the air enclosed in the clothing with fresh air, strong winds, especially if cold, blow right through woven garments and, unless their access is checked, quickly cool the body down. The winds may be kept out by the use of fur, leather, oilskin, rubber or a waterproof textile, which last is usually to a large extent windproof also. Such overwear even if light may be completely effective. Fur is heat-retaining as well, since its hair holds as much as 98 per cent. of air.

Wet clothing entails great heat loss, which may be borne for short periods when taking active exercise, but is dangerous to the body at rest. In a wind the rapid evaporation adds greatly to the risk and a windproof covering over wet clothes is a useful protection.

As regards underwear, it should be adjusted to the weather and not to the nominal season. When the weather is cold, wool is best: when it is hot, cotton. Linen is interchangeable with cotton. Silk is warm, though less warm than wool. Open mesh of silk, linen or cotton or of admixtures of these, owing to its cellular structure, may feel as warm as wool. Flannelette is a cotton fabric made with a fleecy pile which enables it to simulate flannel. It is warmer than ordinary cotton textiles but has in the past been dangerous on account of its inflammability. The tendency to catch fire may be abolished for the time by washing the fabric in water containing alum or sodium tungstate. Thick underclothing is less warm and otherwise less comfortable to wear than two suits of thinner underclothing worn one over the other.

All clothing should be free from constriction, especially about the chest and limbs, and garments should be evenly distributed over the body surface. Outer clothing should be dry-cleaned, or washed, periodically.

The close-fitting shirt-collars now favoured by men do much to conserve the body heat and often render a greatcoat superfluous, though many needlessly use both. Women's clothing today is in general more hygienic than men's. For both sexes the right amount of clothing is the minimum bearable.

Foot-Wear. The soles of shoes or boots should be flat, the toes rounded, that is to say, neither pointed nor square, the welts strong and the heels low. It is important that there should be a cut-in over the insertion of the tendo Achillis in order to fix the shoe in position. Otherwise it chafes the wearer's heel and may raise a blister. A shoe made on these lines should be comfortable to the average foot for ordinary purposes. Fashionable shoes for women may lack the quality of comfort. Opinion is divided on the extent to which they produce distortion, which may sometimes be the evidence of an innate flaw. With a view to a good fit, shoes unless made to order should be selected from a large range of intermediate sizes. The fluorescent screens provided by many firms enable the customer, prior to purchase, to observe whether the alignment of the bones of the foot is correct with the shoe on. Children who suffer from weak ankles should wear ankle boots instead of shoes.

Posture. No person would wish to cut a more ungainly figure than nature has designed. Decorative clothing may be worn to set off the gifts of nature or improve her plan, but the pleasing effect of the best styles may be ruined by an awkward gait. Belts and similar appliances which are claimed by their manufacturers to reduce abdominal and other malpostures should be worn only on medical advice. In standing and walking the chest should be high, the abdomen retracted, the neck vertical and the chin not advanced. This posture, which is correct for both men and women, tenses the abdominal muscles, drives blood out of the splanchnic circulation, flushes the extremities, prevents flat-foot, averts fatigue and fosters self-respect.

Exercise. Physical exercise promotes metabolism and facilitates the removal of waste products from the tissues. It ventilates the lung and activates muscle. It cleanses the skin and keeps the joints limber. Exercise to most people means the muscular effort which they make with the object of keeping themselves in a state of physical fitness. Walking is the most obvious exercise of this kind. It may however be rather dull without a motive to beguile the way, so that many prefer to take it, if they must, in combination with golf, angling or shooting. Horse exercise under all conditions is definitely health-promoting, as is also bicycle riding in moderation. Track cycling however is a severe test of endurance, and the same may be said of boat-racing, though non-competitive rowing is a pleasantly mild pursuit. Swimming is for the strong and vigorous: others may be overtired. Fencing with the foil is not so apt to cause overstrain, as the sword arm and the legs usually weaken before the heart. In general, open-air exercise in the sun and wind or in the wind and rain is more invigorating than exercise under cover.

Physical Training. The exercises of grown-up people, taken as opportunity offers, are rightly enough called recreation, meaning the renewal of bodily vigour which might otherwise tend to lapse. The exercises of children and adolescents, during the period of growth, should be creative and not merely re-creative. They should form part of a system of organised physical training in order that by the time adult age is reached the body and its inherent powers may have been fully developed.

Physical nurture should begin as soon as the child enters school, since sitting at desks, even the best-adjusted, in a state of unnatural immobility may lead to faulty postures. Between the ages of 6 and 9 active games are thought to be the best form of training, combined with some mild rhythmic exercises for the control of the large muscles. Between 9 and 12 it has been suggested that the games should begin to be of a competitive character, and easy gymnastics, calling for skill, should be introduced into the scheme. Between 12 and 15 years boys may be set to harder athletics, such as hurdling. In the case of girls, in whom puberty is approaching, active exercises, while not forbidden, should be subject to supervision.

From 15 to 18 years of age boys may go on to strenuous competitive sports. Girls on the other hand should still be cherished, though without undue restrictions. The Medical Women's Federation have expressed the view that there is no risk in allowing a girl to join in ordinary games and gymnastics during menstruation.

The opinion is held that from the age of 18 onwards both sexes may train for severe athletic events according to their respective powers, the capacity of performance for women being, in general, about three-quarters of that for men. Between 20 and 30 the athlete is at his physical best.

though many men by judicious training are able to maintain a level of achievement long after the latter age.

It is doubtless prudent during adolescence to acquire skill in one of the milder sports as a preparation for the subdued activities appropriate to maturer years: but the benefits of major athletics, such as football and boxing, track-running and boat-racing, do not cease when the athlete finally withdraws from the field, ring or river, as the case may be. His physical endowment of the great days will stand him in good stead later, enabling him in middle age, even after a long period of indolence, to recover fitness, when required, more quickly than is possible for those who have never enjoyed the advantage of physical training. In addition he will always carry with him what he learned from sport in the way of endurance, self-discipline, the team spirit and the sportsmanlike attitude, all of which are good things in any walk of life.

Much is now being done by the Central Council for Physical Recreation to promote community exercises, games and other pastimes in recreation centres and amongst the public at all ages. It is the aim of the Council to encourage physical culture by all methods, both indoor and in the open, and to demonstrate that recreational development can be a source of pleasure as well as profit.

Later Years. The code of health in middle life and after is subject to limitations from which earlier ages are free. Apart from overt or specific disease, tissue changes result with the lapse of years, which when impending call for prevention, and when present for control. The scheme of life may have to be refashioned to meet these new conditions. The circulatory system, which is under incessant wear and tear, is apt to be the earliest affected.

In atheroma, as the heart's reserve power fails, thrombosis may occur in the cerebral arteries. A careful life, a moderate diet and regular exercise without fatigue are recommended in such cases.

In arterio-sclerosis the structural changes may be the result of high blood pressure especially if associated with nephritis. In other cases gout, diabetes or lead poisoning may be the originating cause. In still other cases the individual may be the subject of essential hypertension, a condition which may be discovered accidentally at an early age but more frequently only comes under notice when an important organ shows signs of damage. The rule of life for the control of high blood pressure consists in a diet carefully selected and the prompt elimination of waste products, combined with a modicum of healthy exercise, all under medical direction.

For the prevention of disease of the digestive tract the care of the teeth and suitable food are doubtless of value. For the prevention of biliary or pancreatic disease exercise and draughts of water are useful. Nephritis, acute, chronic or recurrent, may be set up by remote septic foci. For this reason, among others, septic tonsils, nasal sinuses and other infected sites should be rendered innocuous by appropriate methods. The removal of septic foci is prophylactic also of rheumatoid arthritis. Obesity may accompany diabetes and should suggest the possibility of its presence. If glycosuria is discovered the person's way of life must be suitably adjusted.

Among the contributory causes of gout are the use of malt liquor and sweet or strong wines, the consumption of nitrogenous food, especiall if rich in nucleins, and want of exercise. Attacks are precipitated b injury, emotion and unusual excesses. The rule of life for those wh have a hereditary tendency to gout, and for those who have ha premonitory symptoms, is to avoid the contributory causes cited above and especially to adopt a purin-free diet and secure the speedy eliminatio of waste products, under medical advice.

Noise. A sound becomes a noise when it is disturbing or vexatious to the hearer. The usual ground of complaint is disagreeable loudness.

The deafness of boiler makers results from direct injury to th auditory apparatus by loud sounds. In weaving sheds the looms creat a continuous roar and clatter. It was observed that 'defenders' wor in the ears reduced the din by one-half and gave the workers relief. It is agreed that noise is more adverse to mental work than t mechanical work. It may operate both when the work is too difficult and when it is not difficult enough to claim the worker's close attention. With mechanical work there is a fairly rapid acclimatisation to loud noises.

As regards air-transmitted noise, intervening high buildings will provide shelter from it. A plot of ground enclosed by buildings which exclude the roar of adjacent street traffic may enjoy a grateful silence even in the heart of a city. In houses which front on busy roadways the vehicular noise is heard most on the upper floors.

As regards structure-transmitted noise within houses it may either be of external origin or else be generated within the house itself. Flimsy and ill-fitting windows pass external noises freely. Thick plate-glass windows in heavy frames well set in a stout stone building are proof against all ordinary noises of this kind. If further protection is desired double windows may be put in, enclosing between them an air space from 4 to 6 or more inches across. The prevention of internally generated sounds from travelling in houses is dealt with above[1] in the article on flats.

In the measurement of noise a distinction is drawn between (1) *power* and (2) *sensation*.

Power. The power unit of noise is the bel, which represents a tenfold increase in the energy of sound. The working unit is the decibel, which may be regarded as the least perceptible increase in the energy of a sound which can be detected by the human ear under ordinary conditions. Th decibel scale is logarithmic.

Sensation. For equal sensations of loudness the power level of sounds measured in decibels differs for different notes. To meet this divergenc between power and sensation it has been agreed to adopt as the referenc tone or 'reftone' the note having the frequency of 1000 vibrations pe second. This note is just audible at a pressure of 0.0002 dyne pe square centimetre, which gives the zero of the loudness scale. If th energy of this note is *n* decibels above the zero, the loudness is said t be at a level of *n* phons. If a note of any other frequency than that o the reftone is ascertained by means of the noise meter to have the sam loudness as the reftone at n phons, it is said to have a loudness of n phons also. At ordinary noise levels the phon is the least perceptible increase in the loudness which can be detected by the human ear.

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[1] Page 374.

Whispering gives 30 to 40 phons, ordinary conversation 60 phons, a tube train 80 phons and an aeroplane engine 110 phons.

XXII.

HEALTH EDUCATION

COUNCILS

The Central Council for Health Education was instituted in 1927 and is the agency for health propaganda in England and Wales. Its general object is to assist local authorities in their work of prevention by educating the public in the use of the health services and in the principles of healthy living. It is the expressed view of the Council that 'Health of mind and body is the basis of happiness and good citizenship.'

The subscriptions of local authorities, payable on a quota basis together with a grant-in-aid from the Ministry of Health, provide for the Council's central organisation which, in addition to the production of a large volume of propaganda publications, sold to local authorities at cost price, makes available free of charge the organising services of 12 area representatives throughout England and Wales. A team of expert speakers is also available who undertake at agreed charges courses of lectures to teachers, youth leaders and others interested in the cause of health education. Subscribing local authorities are entitled to a return of one sixth of their quota payments in the form of free lectures or literature.

The Council has also produced a number of films either separately or in conjunction with the Ministries of Health and Information. Subscribing local authorities may have these films on loan without charge.

As the central co-ordinating body for England and Wales in all aspects of health education, the Central Council has, since 1942, assumed responsibility for educative propaganda in the field of venereal disease. The Council undertakes also the publicising of diphtheria immunisation and similar campaigns, and collaborates with the Ministry of Health in the preparation of press advertisements on health matters which are issued over the joint imprint of the Ministry and the Council.

Two periodicals are published under the Council's auspices. One, a popular monthly magazine entitled 'Better Health,' circulates amongst the public generally. The other, the quarterly 'Health Education Journal' is designed for doctors and educationists and contains specialist articles.

Health propaganda by radio is also the concern of the Council, sponsored by its medical adviser and education officer respectively.

Health propaganda on similar lines is undertaken in Scotland by the Scottish Council for Health Education. The Council functions through the major Scottish local authorities all of which are contributors to its funds and are represented on the Council either directly or through the Local Authority Associations.

The Council was set up in 1943 as the result of the joint efforts of the Secretary of State and the Local Authorities, in order to cover the whole field of health education in Scotland. Membership of the Council is limited by its Constitution to appointed representatives of certain Local Authorities, Local Authority Organisations, other specified organisations, and the Secretary of State. The Council has power to co-opt persons of special knowledge and experience.

The Council assists statutory and other bodies in Scotland by providing educational and publicity services for any purpose relating to health, and to that end arranges meetings, health weeks, demonstrations, exhibitions, film shows, conferences, and broadcasts. It also publishes a wide range of leaflets, booklets and posters on health subjects.

The Scottish Council does not function on the area plan, its sole administrative unit being situated in Edinburgh. Its principal executive officials are the Secretary and Treasurer, the Medical Adviser, who is a part-time officer, and a full-time medical lecturer who undertakes health propaganda with special reference to rural areas.

An important activity of the two Councils for Health Education are the Summer Schools which attract many persons who are interested in the problems of public education in health. By a special arrangement, 10 per cent. of the places in each English school are made available to Scottish students and *vice versa*. The Scottish schools at the Universities of St. Andrews and Edinburgh have in past years offered both elementary and senior courses in physiology, educational psychology and social medicine by expert tutors of professorial grade. Guest speakers in the person of prominent men of science have been a feature of these meetings. A recent innovation has been the provision by the Council, on the general theme of 'The School and Health,' of a vacation course in the psychology of education, including delinquency, educational discipline and the social aspects of the school, together with a course in hygiene which took the form of nine model health lessons suitable for young children and, with appropriate modifications, for senior pupils. In addition to these courses, specialist speakers dealt with such background problems as school environment, physical handicap, social investigation, vocational guidance and family life. The fact that teachers, social workers and medical personnel attended these courses in large numbers suggests that there is a growing demand for such instruction and that it is upon youth that the accent of health education must be placed. The schools organised by the English Council have been more in the nature of symposia, covering many fields of the subject, by means of a large panel of speakers. The value of these schools as training grounds for missioners of health can scarcely be over-estimated.

In planning health campaigns of any sort the fullest advantage should be taken of the publications, exhibits and other facilities offered by the Central and Scottish Councils for Health Education aided in special fields by kindred important organisations all as shown in Table 42.

TABLE 42.

HEALTH EDUCATONAL ORGANISATIONS

ORGANISATION.	ADDRESS.
British Dental Association.	13 Hill Street, London, W. 1.
British Social Hygiene Council.	19 Tavistock Square, London, W.C. 1.
Central Council for Health Education.	Tavistock House, London, W.C. 1.
Central Council for Physical Recreation.	58 Victoria Street, London. S.W. 1.
Empire Rheumatism Council.	106 Finchley Road, London, N.W. 3.
National Association For Prevention of Tuberculosis.	Tavistock House, London, W.C. 1.
National Council for Maternity and Child Welfare.	117 Piccadilly, London, W. 1.
Scottish Council for Health Education.	3 Castle Street, Edinburgh, 2.

PROLEGOMENA

Health education is intended to be wide-ranging. It can be adapted to all sorts and conditions. Even babes and sucklings can share its genial influence as when the expectant or nursing mother at a pre-natal or infant clinic of a local authority is advised regarding her personal health or that of her infant. The benefits of immunisation can be explained to her and the principles of healthy living taught. The orderly arrangements of the clinics and their equipment plays a not unimportant part in pointing the lessons of cleanliness and method. The pre-school child is on the whole less well served, though when in attendance at a day nursery or nursery school it can learn the elements of personal hygiene. Similarly in the dispensaries of the tuberculosis and venereal diseases schemes there is ample scope and opportunity for instruction in right ways of life. The domiciliary activities of the health and tuberculosis visitors do much to inculcate the principles of domestic hygiene. In the meantime these various agencies reach only a fraction of the people and the need for constructive propaganda is correspondingly great.

SCHOOLS

By contrast with the procedure outlined above, which tends to be intermittent, uncertain or even fortuitous, the world of school presents a system of established order carrying momentum enough to ensure continuity and shaping, under authority, the youthful mind by the study of approved and appropriate subjects. In such a system health education may properly claim a place, side by side with the other 'lessons' in school or blending with them.

Health education in schools may be given by such means as leaflets composed for young children and, for older children, selected cinema films, apt and humorous school posters and special teaching material, which will be supplied, on request, by the Councils for Health Education.

In our view the Primary School Teacher should deal with laws of health and the Secondary School Teacher with more advanced matter and biology. Specialists such as the gymnastic teacher could stress the importance of correct body movement, fitness and the like. We believe moreover that the schools campaign should be combined with an intensive campaign amongst parents. Children should be encouraged to show their leaflets at home. The psychology of the leaflet is most important in this connection. Leaflets and other literature should make a definite appeal to the sense of parental responsibility.

The appropriate Health Council could, with the permission of the Director of Education in each area, pass through him guide literature to the teachers direct.

The school medical officer could act as liaison officer and, if he thought fit, address the teachers on the aims and objects of the instruction, either by circular letter or by personal appeal.

The medical officer in our view should act behind the scenes in so far as young children are concerned. His approach is best to the teachers. For older children the position is rather different. To them the doctor can appear in his proper place as the 'guardian of health.' Occasional talks, therefore, by the school or other medical officers would be helpful. This could be done by school broadcasting in fortnightly or monthly series, either by the medical officer of health's personnel or by outside speakers, such as those of the Health Education Councils. It is best, we think, that each series should be conducted by the same speaker. More advanced leaflets could supplement the talks, or be published in connection with them.

When the time arrives to put the scheme into operation, the senior school medical officer could usefully act as its co-ordinator. Much more use could, with advantage, be made of the school nurse in the education of children in health matters. It is on this account not unlikely that some school nurses and health visitors may in the future elect to specialise in health teaching. There are many obstacles to be surmounted before routine health education in schools becomes an established fact, but though differences of opinion exist as to the most effective method, all are unanimous that the need for health instruction is clamant.

PROPAGANDA OF HEALTH

What is required of health education is to make known to the general public the principles of healthy living and, having made these known, to keep the public interest appropriately alive to their importance. The propaganda now favoured for the achievement of these ends is promoted through a variety of agencies, too various to be classified by a word. A few such agencies have already been mentioned. The following is a completer list: the Press, leaflets, brochures and posters, health lectures, the cinematograph, wireless broadcasting, health exhibitions, open air displays and health weeks.

The discussion of each of these agencies *seriatim* and *in extenso* which now begins and continues thereafter to the end of this Section, may it is hoped serve for the guidance of all who are concerned in the promotion of health propaganda.

MEDIUM OF THE PRESS

Much valuable publicity for health matters may be obtained through the medium of the press. Many newspapers will accept short articles of a topical nature, and room can generally be found for notices of proceedings at public health conferences, and for statistical or otherwise appropriate extracts from the reports of medical officers of health. When set in the *obiter dicta* column, such extracts have a high propaganda value. Local, and especially country, papers, which together total over 1,000 in Britain, are more willing to afford space than are the national dailies, which are concerned mainly with condensed news of world affairs and sport. The local paper is frequently the staple reading of many of its subscribers and the discussion of health matters in its columns is on this account more likely to make a lasting impression. Sunday papers, which have a vast public, are an excellent medium for the diffusion of health knowledge. They willingly grant interviews to medical officers who may wish to bring to the public notice some important aspect of community hygiene. It should not be forgotten, also, that a well-written health article is an admirable counter-measure to the multitudinous advertisements of patent nostrums and 'cure-alls' in which both the national and local press abounds. Care must be taken in the preparation of articles for the press to avoid sensationalism. Articles which are appealing from the purely journalistic point of view may do a serious disservice to the cause of health, partly by inadvertent misrepresentation, and partly by the emphasis, out of context, of the more dramatic aspects of the topic. There is thus need for a careful editing of copy in such cases.

Articles intended for publication in a newspaper should average 400 to 1,000 words in length and should be written in simple language with a light or even humorous touch. 'Health with a Smile' should in fact be the underlying theme of their message. Wherever possible a telling headline should be chosen, and an appropriate illustration will assist in driving the lesson home. Every effort should be made to encourage newspapers and periodicals to accept such articles, and to give them a reasonable prominence, especially during health weeks and exhibitions. At such times, a daily series of short paragraphs with happily chosen titles are alike good publicity for the current event and useful health propaganda afterwards. There should where possible also be a brief note in the 'day by day' or gossip column which is likely to be read by everyone. Advertisements of health displays and similar events are in themselves an excellent form of health publicity. Every care should therefore be taken to ensure that they are simple, apt and topical.

It is a good plan for the medical officer of health to convene a press conference with representatives of the principal newspapers both before the health event and at its conclusion. He should on these occasions express himself respectively on the objects of the campaign and the degree of success to which in his view it has attained. The application of a circumspect journalistic technique to his statements lends to them a popular appeal which is lacking from the sober reports made to committees, besides making them available to a wider public.

The Periodical is second only to the newspaper as a medium for the dissemination of health information. Occasionally it takes the form of an exclusively health magazine, as for example the 'Health Education Journal' of the Central Council for Health Education. Sometimes, as in the case of the monthly publication 'Parents,' the periodical lays special emphasis on child health topics against a general background of healthy living. The various women's magazines in most cases feature one or more health articles in each issue. These not infrequently have a cosmetic approach and deal with the care of the skin and hair, or with exercises for muscle tone and the like, but all have a definite value in the promotion of healthy living. There is also an excellent field for health propaganda by medical men in the more specialised periodicals such as the 'Nursing Mirror' and kindred publications, which circulate extensively among the nursing and allied professions. Articles prepared for such papers should stress the need for getting the facts over to the public, and should therefore make an appeal to readers to act as health missioners in the course of their professional work. The proprietors of the national weekly picture papers may from time to time be willing to splash a lavishly illustrated health article as the feature of a particular issue. This practice is of the greatest value, not only because these publications are very widely read, but also because the numerous photographs, with their captions, largely tell the story, thus making it unnecessary to read in detail columns of text. In addition, moreover, to those who may buy them, the magazines are available to a still larger clientele in public reading rooms, in youth and service clubs and in factory canteens. By mounting the pictures in series with their original, or simpler, captions, useful exhibits for the instruction of children or for display during school health weeks are readily obtained. In order to arouse keener interest, the children may themselves be allowed to cut and mount the illustrations, and to devise their own captions. By this simple yet instructive means the message of the pictures is more readily impressed upon the mind.

The question regarding the disclosure of the identity of medical writers to the lay press is still unsettled and needs decision.

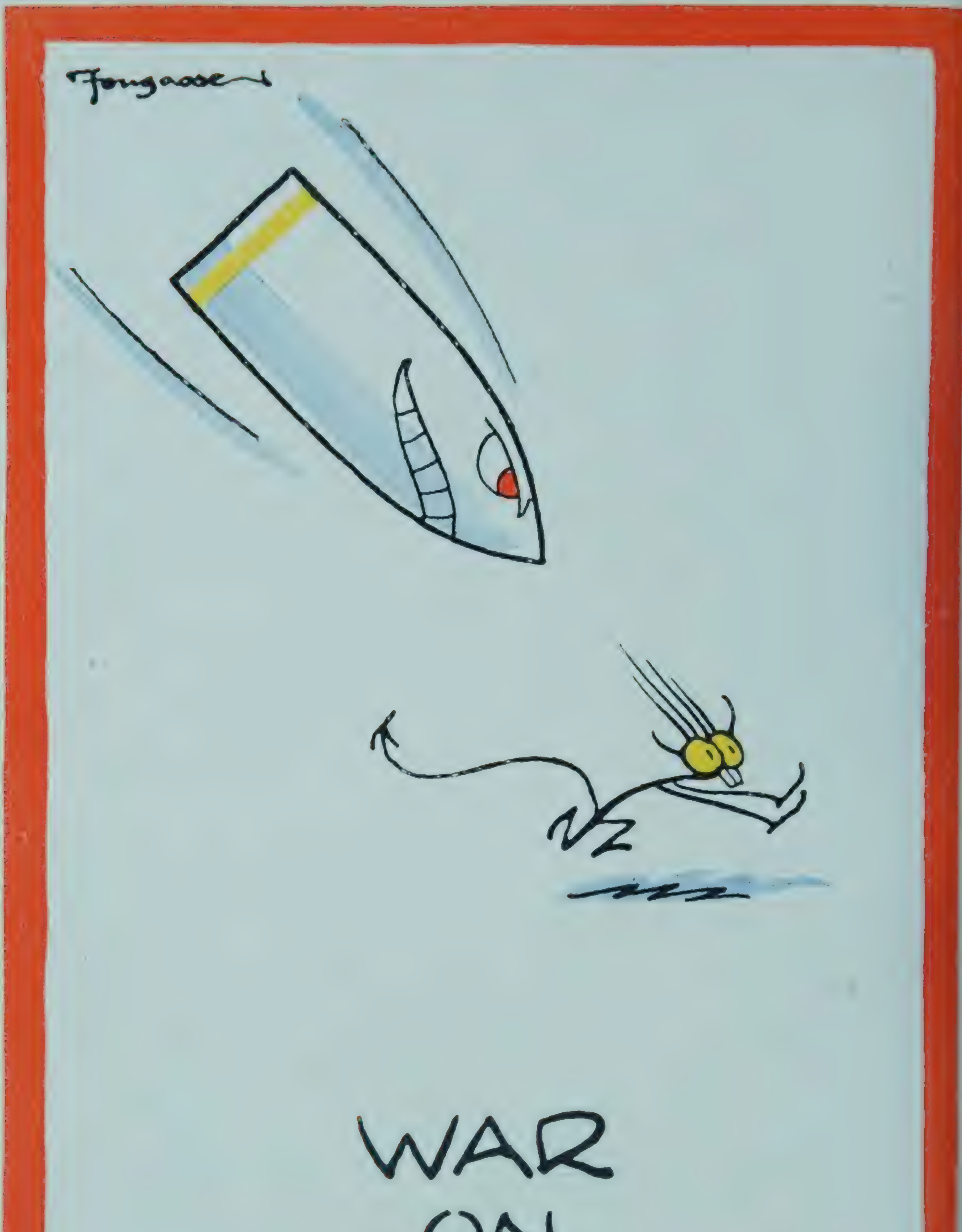
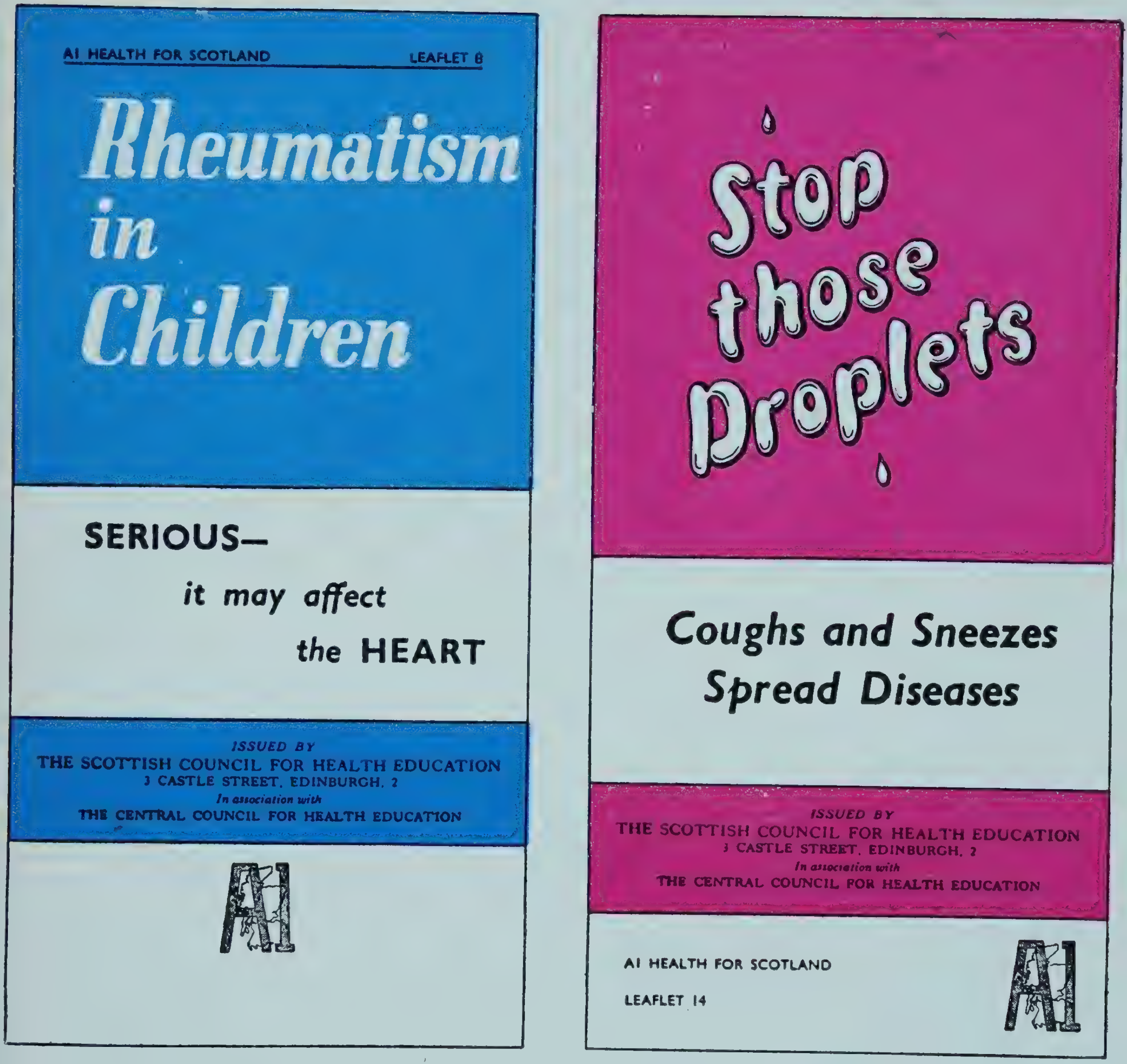

Fougasse
WAR
ON
DISEASE

Fig. 194.—Health Leaflet by 'Fougasse.'

LEAFLETS

For health propaganda purposes leaflets should be neatly printed in clear type on good quality paper of handy size. Inferior paper takes printed characters badly and makes no visual appeal. The text of the leaflet should be brief, and the style at once lucid and attractive. The choice of a colour is important and where possible it is a good plan to identify specific health topics with certain colours or colour consonances. Thus jade green may be employed for tuberculosis and blue for child care. It has been ascertained by the experimental issue of leaflets in 10 different colours that shades of blue, brown or green are the most readily taken. The leaflets may either be printed on a pastel-tinted background of the chosen colour, or on white or cream laid paper surrounded by a coloured border. Deckle edge papers, and cut outs, are rather more expensive, but their greater cost is often repaid by their effectiveness.



A1 HEALTH FOR SCOTLAND LEAFLET 8

Rheumatism in Children

SERIOUS—
it may affect
the **HEART**

ISSUED BY
THE SCOTTISH COUNCIL FOR HEALTH EDUCATION
3 CASTLE STREET, EDINBURGH, 2
In association with
THE CENTRAL COUNCIL FOR HEALTH EDUCATION

A1

Stop those Droplets

Coughs and Sneezes Spread Diseases

ISSUED BY
THE SCOTTISH COUNCIL FOR HEALTH EDUCATION
3 CASTLE STREET, EDINBURGH, 2
In association with
THE CENTRAL COUNCIL FOR HEALTH EDUCATION

A1 HEALTH FOR SCOTLAND
LEAFLET 14

A1

Fig. 195.—Health Leaflets.

A superabundance of types should be avoided in printing leaflets. Main headings should be in Clarendon or similar fount, and matter for special emphasis in italics or underlined. The question of illustrations will be determined by the subject under discussion. Line blocks are generally to be preferred to photographs for instructional purposes. For artistic embellishment a high quality photograph makes the greater appeal. There is a wide scope for the humorous cartoon in the production of leaflets and it should be employed wherever possible. Among the most successful of health leaflets have been those issued jointly by the Central or Scottish Councils for Health Education decorated by the appealing sketches of 'Fougasse' (Fig. 194). Captions if any, should be of the briefest, and aptly chosen. Fig. 195 exhibits two leaflets which have proved popular in health campaigns.

Much of the success of a leaflet depends on the cogency of its title. Quizzical, terse or punning titles arrest the attention and ensure that the text at least receives a glance. Literature bearing such captions, for example, as 'Breath of Danger,' 'Right Dress' and 'Just Nerves,' is readily taken by the public at health exhibitions and similar displays.

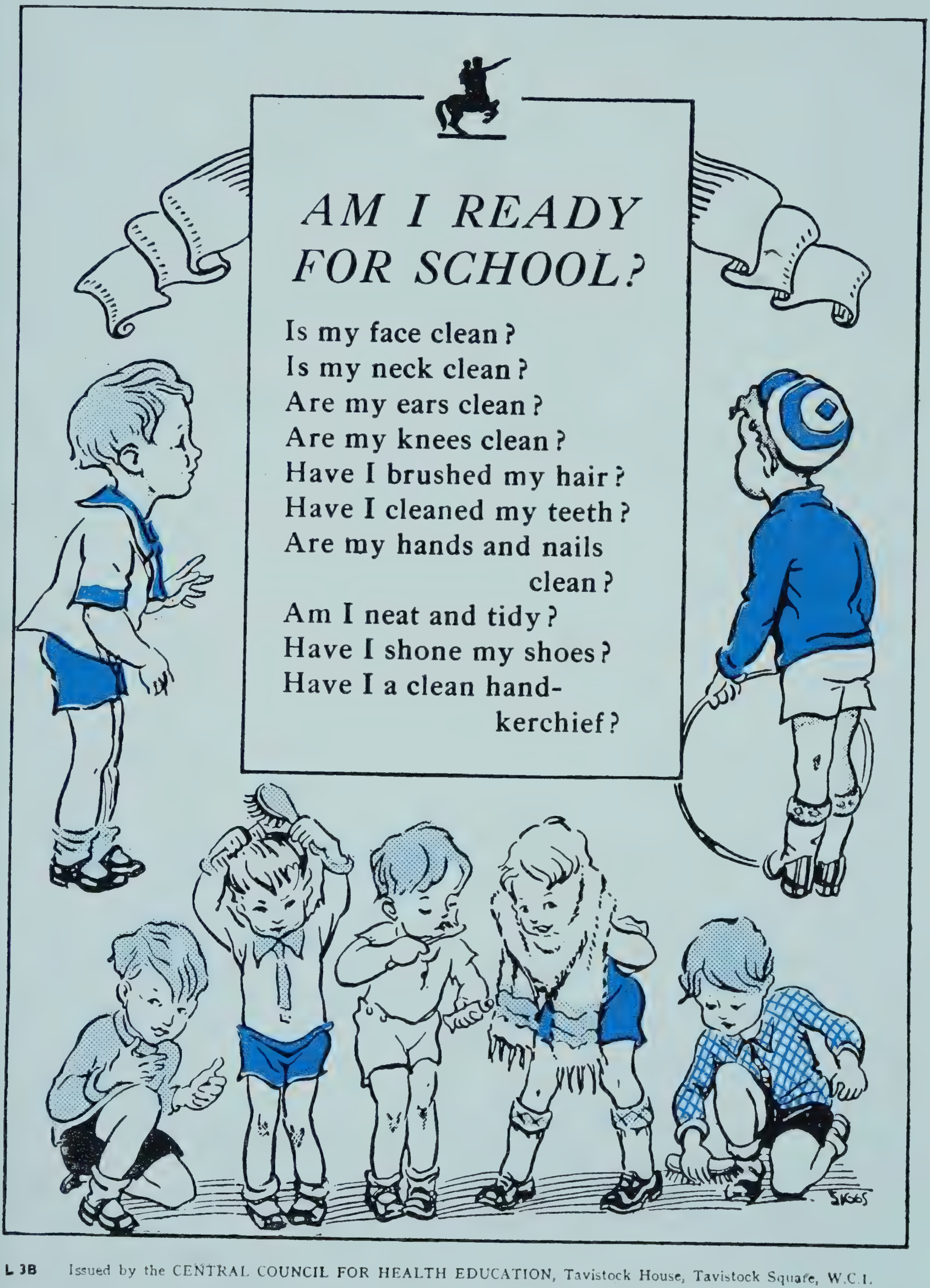
It is a moot point whether leaflets should be issued *ad libitum* or given on request. Much will depend on the nature of their contents. Issue on the 'please take one' system leads to the appropriation of many leaflets by irresponsible persons who soon throw them away. At health exhibitions it is a good plan to have supplies of relevant leaflets at the various stands to be handed out on request, or to persons who seem genuinely interested either in an exhibit or in the health topic which it concerns. It is the practice of the Scottish Council for Health Education at public meetings on health subjects to hand an addressed reply-postcard containing a relevant leaflet to each member of the audience on entering. Each leaflet should display a short list of related publications for the guidance of readers who may wish to explore the subject more fully.

BROCHURES

These are merely leaflets designed on a more ambitious plan and in a more permanent style. What has been said of the make-up of leaflets applies also to them. The brochure is of value in imparting after-care advice to tuberculosis patients on their discharge from sanatoria, for issue to the patients at venereal diseases centres and for placing in the hands of parents who accompany their children to school medical inspection. The brochure should be of a convenient size for the pocket, since patients may wish to carry it about for reference. The programme used for a health week may usefully take the form of a brochure of a 'keep fit' character, the centre pages of which set forth the order of events for the week.

POSTERS

Skilfully designed posters are an essential of the health campaign. The message of the poster should be short and telling and the colour consonances attractive. It is better to have a large number of small posters of, say, half-imperial size than a few costly large ones. Dwarf



AM I READY
FOR SCHOOL?

Is my face clean?
Is my neck clean?
Are my ears clean?
Are my knees clean?
Have I brushed my hair?
Have I cleaned my teeth?
Are my hands and nails
clean?
Am I neat and tidy?
Have I shone my shoes?
Have I a clean hand-
kerchief?

L 3B Issued by the CENTRAL COUNCIL FOR HEALTH EDUCATION, Tavistock House, Tavistock Square, W.C.1.

Fig. 196.—Health Poster.

posters appeal to children (Fig. 196). The best positions should be chosen for the posters and their lettering should be clearly visible at reasonable distance. An apt cartoon adds to the appeal of a poster, but it should not be allowed to obscure the text.

HEALTH LECTURES

Health lectures form an integral part of the propaganda scheme. They may be given as a feature of an intensive health campaign, or regularly throughout the year as part of a long-term policy of health education. The subject matter of such lectures should make a popular appeal, and titles should be chosen which will arrest the attention and arouse the interest. The widest publicity should be given to the lectures by every available means. It is essential to choose speakers who have a good platform presence, a clear delivery, an informative yet easy style of address and the ability to deal frankly with debatable problems of community health. Too frequently, lectures are entrusted to individuals purely on the ground that they are acknowledged authorities in their particular field of study. That is not enough. It is much more important from the point of view of health education to secure speakers who have the gift of lucid and illustrative exposition, though perhaps less expertly versed in the details of the subject. Simplicity must be the keynote of health lectures to the laity. The aim of the lecturer should be to put before the public the broad facts of the chosen topic, emphasised if desired by the quotation of a few intelligible statistics, and to stress such commonsense principles of prevention as may apply in the case. Technical details are unnecessary, scientific terms should as far as possible be restricted, and the morbid element rigorously suppressed. The lecture should never exceed forty-five minutes in length and is best limited to half an hour. Fifteen minutes is usually sufficient for the 'lecturette' which accompanies a film display. In the case of general health talks, the approach should be light and even racy. Lectures on tuberculosis or cancer should strike a note of hope. Those on venereal disease should be fearless. The speaker should in all cases be sure of his facts, and be prepared to stand by any statements he may make.

Not the least important feature of such lectures is the question period. Questions may be spoken or written. The latter method is much to be commended, since it restricts the discursive questioner and encourages those who are too shy to enquire verbally. A supply of cards should be available from the ushers who will in due course collect the questions and pass them to the platform. A further advantage of the card method is that a record of questions asked is automatically provided and may lead to the inclusion, in future lectures, of points which had been omitted. The specific time set aside for questions, usually 15 to 20 minutes, should not unreasonably be exceeded. Extensions should be decided by the chairman. To those whose questions have not been answered from lack of time, the suggestion should be made that they direct their enquiries either to the medical officer of health or to the appropriate Health Education Council. Answers to questions should be as frank as possible. If the speaker does not know the answer he should say so without hesitation. Side-tracking merely irritates an audience. Should the lecturer hold strong personal opinions on a subject he is of course entitled to express them; but he should see to it that his views do not openly contradict the considered policy of the public health department. Otherwise serious confusion may arise in the public mind.

It frequently happens, and should be the rule, that the press is invited to be present at health lectures. It is advisable that the speaker should spare a few minutes to meet their representatives, either before or after the lecture, in order to confer regarding facts to be published or points to be stressed.

CINEMATOGRAPH

This instrument figures in a variety of ways as a method of health propaganda. It plays an important part in the instruction of school children. It finds a place in health exhibitions, for the projection of short documentary films. In the form of the cine-motor van it takes health propaganda alike to the city streets and the country lanes. In the public cinema it serves to underline the speaker's words at health lectures. Its themes may be local or national, and transmitted either by direct photography or by means of animated cartoons in monochrome or in technicolour. It is inexpensive, in that its initial cost is repaid many times over in propaganda value.

The films available vary in dimensions. Standard film, of 35 mm. gauge, is employed mainly in public cinemas and halls equipped with fire-proofing arrangements. Sub-standard film, of 16 mm. gauge, is obtainable in non-inflammable form suitable for exhibition anywhere. The films may either be of the silent or sound-on-celluloid type. A variety of electrically driven and readily portable projection apparatus, more or less standardised, is now on sale or hire to run on domestic current varying from 220 to 250 volts. The machines are easy to operate and will fill a screen of reasonable size without difficulty.

A large selection of health instructional and documentary films are available from various sources and have been classified by the British Film Institute, to whom application should be made for the catalogue which sets forth for each film such details as title, running time, sponsor and hire charge. While the sound-on-film system is now almost universally employed for instructional purposes, many teachers prefer to give a personal commentary, and so choose silent editions of the films. The readily obtainable co-operation of the Central and Scottish Information Offices, formerly the Ministry of Information Film Service, should be sought when health propaganda by the film method is contemplated. When there is to be a speaker, at least one of the films should be related to his topic, or to a cognate subject. Hiring charges are reasonable, and every opportunity should be taken to use films in the health campaign whether in schools, in factories, in clinics or for the general public.

Projectors employing miniature slides (2″×2″), and film strips for still pictures are now procurable, and are a useful substitute in school classes where cinematograph apparatus is not available.

A word is required regarding the propaganda cinema lecture to the public. It may either be devoted to general health and cleanliness topics or take the form of a specialist talk on, say, venereal diseases or tuberculosis. The points already made regarding health lectures, speakers and questions in general apply also to cinema talks and should receive attention. Since the hire of a cinema is fairly expensive, a first grade theatre costing up to £25 for one evening, the fullest publicity should be given to the lecture, both by poster and in the press. Leaflets relative to the subject to be discussed should be issued to each person on entering.

Care should be taken in arranging the programme, especially with regard to timing, so that the evening passes smoothly and the interest of the audience is thereby sustained. The publicity for cinema lectures should be attractive, and titles such as 'Quiz the Doctor' or 'Your Questions Answered' have been found effective. Care should be taken that the speaker is reasonably familiar with the microphone.

WIRELESS BROADCASTING

For health propaganda, wireless broadcasting commands by far the largest audience and should be employed to a much greater extent for this purpose. 'Keep fit' lessons, broadcasts to schools, talks from individual stations, items in magazine programmes, publicity in regional news bulletins during local campaigns, and recordings of outdoor health week activities, for re-broadcast later, represent the principal ways in which the radio may play its part in furthering the cause of health education. Talks intended for broadcasting should be brief, topical and informal, even colloquial. The rules of the British Broadcasting Corporation demand that a full script be prepared for each talk, which shall be subject to the approval of the Corporation, whose decision is final. The broadcast may either be 'live' or electrically recorded for subsequent transmission. In either case, a rehearsal for time adjustment is required. All enquiries regarding broadcast matters should be addressed to the Director at the appropriate regional station.

HEALTH EXHIBITIONS

Health exhibitions may constitute a health campaign in themselves or they may serve as a feature of health weeks. They should not be held too often, otherwise public interest palls, and it becomes increasingly difficult to find novel attractions.

The exhibition may be arranged in various ways, but certain general principles should be observed in order to achieve the best results. It should first be borne in mind that the majority of the visitors are lay persons who will in all probability file through with little more than a glance at each exhibit. It should therefore be the aim of the promoters to produce a compact display which will transmit its message *visually.* Elaborate captions should be avoided, especially those in small print or typescript. It is much the best plan to engage a poster artist to undertake the entire range of captions, whether posters, cards or line drawings. This ensures a result which is at once uniform and aesthetic. All lettering should be clearly visible at a reasonable distance, and attractive colour consonances and contrasts should be chosen. Exhibits should be topical, and working models always compel the interest.

It should be the purpose of the exhibition, by whatever method it is accomplished, to demonstrate the various activities of the public health department and its associated undertakings. On this plan the exhibition may conveniently start with a short section on eugenics, largely photographic, for which appropriate material may be had on loan. Next comes the exhibit on maternal and child welfare, which should stress the importance of antenatal care, breast feeding, mothercraft and infant hygiene. Demonstrations of feed preparing, and of layettes, baby clothing and perambulator outfits are attractive, and room should be found for expositions relating to the day nursery and the nursery school. The suggestion that there should be a model day nursery in session, with children, is in our view strongly to be deprecated. The school health section, which comes next, should if possible mount enlarged photographs pointing to the improvement which has resulted in child health during the more recent years of the present century. Stress should be laid on the school meals and milk-in-schools schemes, and there should be a comprehensive pictorial display of the school medical service including general, dental and orthopaedic clinics. Designs of modern schools should be shown, and the importance of physical recreation and playing fields should be emphasised. The services for the prevention of infection come next in order, and lend themselves to a comprehensive and compelling display. Among the exhibits which should figure in this department are photographs and plans of modern infectious diseases hospitals, including cubicle isolation units, therapeutic antisera and modern anti-microbic substances such as the sulphonamides and penicillin. The exhibit devoted to tuberculosis should display views of the modern sanatorium in all its aspects, the tuberculosis clinic and the mass miniature radiography unit. A strong note of hope should be sounded by this section, and the importance of early diagnosis stressed. Emphasis must also be laid on the social aspects of the disease and also on its relationships to food, housing and industry. The exhibit dealing with venereal disease should show charts of incidence, examples of modern remedies and striking posters which emphasise the risks of untreated venereal infection.

The rest of the space should be taken up mainly by environmental displays, including working models, illustrating the importance of a clear atmosphere, pure water, effective waste disposal, good housing and sound food. Exhibits on nutrition, milk production, the meat industry and the laboratory services may with advantage also be arranged. They must, however, not be too technical, or so crowded that the uninitiated will fail to appreciate their meaning.

All statistical material should be simple yet arresting, and in this connection the bar and sector diagrams, and the charts of the Isotype Institute[1] are strongly to be recommended.

The keynote of the health exhibition should be the stressing of the importance of personal hygiene, sunshine, fresh air, rest and exercise in the maintenance of community fitness. This should be done not only in the individual sections but also generally by such slogans as 'your health—the community's wealth' and the like. Artistic and surrealist murals are of great value in epitomising the underlying theme of the exhibition.

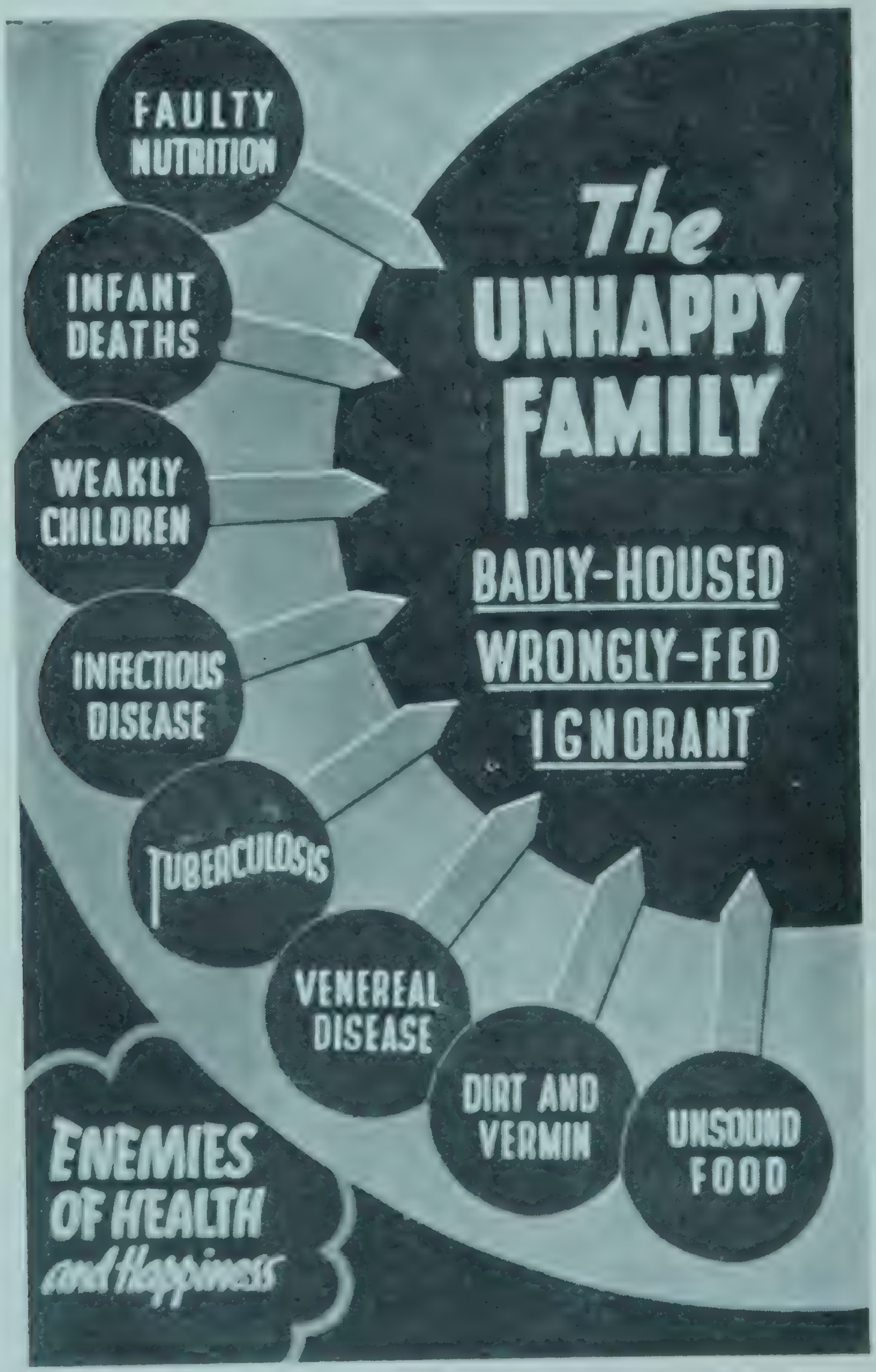

FAULTY NUTRITION
INFANT DEATHS
WEAKLY CHILDREN
INFECTIOUS DISEASE
TUBERCULOSIS
VENEREAL DISEASE
DIRT AND VERMIN
UNSOUND FOOD
The UNHAPPY FAMILY
BADLY-HOUSED
WRONGLY-FED
IGNORANT
ENEMIES OF HEALTH and Happiness

Fig. 197.—Health Exhibition Poster.

It is a *sine qua non* of success that a sufficient number of health visitors, nurses and sanitary inspectors should be in attendance at the exhibition to act as guides and to answer questions. All must be primed on the exhibits, and ready to explain lucidly any matters which may be obscure. Adequate supplies of relevant publications should be available on request at all points.

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[1] Page 196.

A novel method of presentation was adopted by the Scottish Burgh of Paisley for its health display at a recent civic exhibition. The sections fell into two groups representing 'the unhappy family' and 'the happy family.' These twin themes were placarded at the entrance

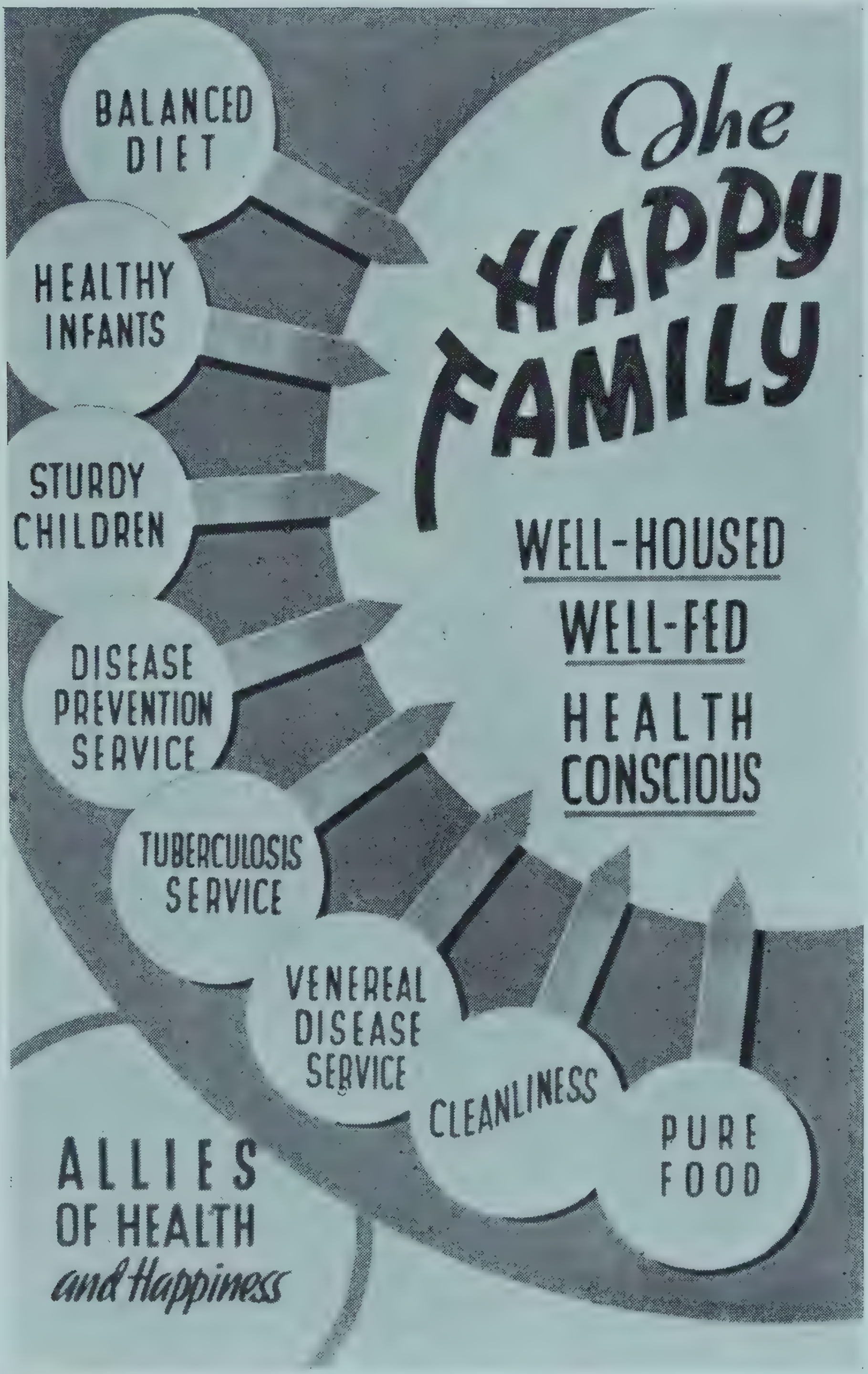
The
HAPPY
FAMILY
WELL-HOUSED
WELL-FED
HEALTH
CONSCIOUS
BALANCED DIET
HEALTHY INFANTS
STURDY CHILDREN
DISEASE PREVENTION SERVICE
TUBERCULOSIS SERVICE
VENEREAL DISEASE SERVICE
CLEANLINESS
PURE FOOD
ALLIES OF HEALTH and Happiness

Fig. 198.—Health Exhibition Poster.

(Figs. 197, 198). The contrast between the conditions which too often prevail, and those for which we are now striving was most impressive.

Among the side attractions of the health exhibition are the cinema, the nutritional cookery demonstrations and the displays of domestic labour-saving devices. The cinema should provide short programmes of say 30-40 minutes, featuring health films and related documentaries. It is advantageous to have a brief commentary by a medical officer at the end of each performance, followed by a short question period.

Cookery and dietetic exhibits or demonstrations should be of a practical and commonsense character. The issue of recipes for simple and nourishing dishes or meals heightens the public interest, and is at the same time a valuable educational activity.

OPEN AIR DISPLAYS

Such displays, which make an appeal to young and old alike, are excellent health publicity. They may take the form of athletic meetings, of children's sports galas or of folk dance festivals. The gathering cry for such displays should be 'Health through Fitness' and every effort must be made to emphasis the benefits which derive from engaging in recreative exercise. The displays should be planned in full conjunction with the Central Council for Physical Recreation. The range of healthful activities possible in the open is very wide. Prominent in the list are swimming galas, net and other ball games and massed physical training displays. Folk dancing, in costume, of the Highland, Morris, Old English and Sicilian types is universally popular, largely because it is colourful, and within the reach of ordinary people who cannot claim the stamina or prowess for athletics. This is in fact the secret of success in health exercises—to offer something which will give pleasure and in which all can join.

The open air festival is an excellent substitute in those years when no health week is in progress. In such cases, the 'open air doctor' should make brief appearances at the microphone with trenchant health talks. It is an excellent plan to give the talk in the form of an accompanying commentary to simple exercises which are actually in progress, explaining the benefits of the various movements and stressing their suitability for the man in the street. The publicity for open air displays should be colourful and gay.

HEALTH WEEKS

The purpose of a Health Week is to encourage the whole community to take an intelligent interest in the principles of healthy living, and at the same time to demonstrate the preventive services which are available through the local public health department and its kindred undertakings. Much of the interest generated by a well-planned health week can be rendered permanent, if the lessons are driven home by periodic activities on a less ambitious scale, and in the form, say, of cinema lectures throughout the winter or open air displays in summer. This should be kept in mind when a long term health policy is being planned, since it is by such repetitive methods that communities in time become health conscious.

The success of a health week depends largely upon skilled planning and expert publicity, and in this connection the aid of the Area Adviser of the Central Council for Health Education or in Scotland that of the Secretary of the corresponding Scottish Council should be sought at the earliest. The first step in the promotion of the week, and one which must be taken some months in advance, is to appoint a small organising committee of, say, six to seven persons comprising the Medical Officer of Health, the Director of Education, and representatives of the appropriate Health Council, the voluntary services, including the British Red Cross Society, and the youth organisations. The chairman may usefully be the convener of the local public health committee. It should be clear at the outset that the committee is a working one and to this end it is a good plan, once the provisional programme has been drawn up, to place the responsibility for a particular phase of the week's activity in the hands of each member. Ideally, the week should be arranged for the spring, when the weather is likely to be propitious, and before the holiday season has begun to thin the local population. It is advisable to plan for a nine day 'week', so as to have two week-ends.

The major activities of a health week are (1) Publicity, advance and current, (2) Schools Propaganda, (3) Cinema Lectures and Brains Trusts, (4) The Health Exhibition, (5) Women's Meetings, (6) Church Aid, (7) Youth Rallies, (8) Open Air Displays, (9) Factory Campaigns and (10) Health Services in Action. Contemporaneously, various displays may be arranged locally, and the youth organisations may devote their meetings of the week to the purposes of health propaganda.

Wide and arresting publicity well in advance is essential for the success of the enterprise. In addition to the distributed official programme, which should take the form of an illustrated health brochure containing the list of events in a centre slip page, the aid of the Press should be sought some two or three weeks before the campaign is due to begin. Newspapers should be approached officially with the request that they feature short pre-view notices of some 10-20 lines regarding the various activities in prospect. Shortly before the week arrives the medical officer of health should convene an informal press conference to which should be invited not only the representatives of local papers but also those of the national dailies. At the conference, the medical officer should give a brief but clear exposition of the aims of the week, and of the methods to be followed for their achievement, and should appeal to those present to give all reasonable publicity to the undertaking. Copies of the detailed programme of events should be available for all, and the object of the conference will be greatly furthered by handing to each representative a short typescript synopsis of the proposed activities and a *précis* of the remarks made by the medical officer, who should be ready to answer any questions put. In the case of a large undertaking, it is wise to invite women journalists to a separate meeting, in order that health publicity from the feminine angle may receive adequate recognition. A request should also be made to the newspapers that they feature a series of health articles in a position of reasonable prominence day by day during the week. The articles should be brief and concise and written with a light touch. Aptly chosen or catch-phrase titles will ensure that they are read, and the inclusion of a simple and relevant line block, especially when it takes the form of a cartoon, is highly to be recommended. Much favourable comment followed the publication, during health week in Edinburgh, of a series of articles captioned respectively 'Battle for Health', 'Women and Children First', 'This Unhappy Breed', 'Eyes

Right', 'Take it Easy' and so forth. Newspaper competitions in connection with health week are eagerly supported, and benefit the papers and their readers alike. They are well worth a trial if space can be found for them. The local papers should also be asked to print a daily diary of events, extracted from the official programme. Much good may come from related comment, either in the editorial columns or elsewhere: a supportive leader on the purposes of the campaign offers invaluable publicity. Finally, good quality press photographs of selected events make a highly popular appeal, especially when they deal with children's pageants or tableaux. Publicity other than that afforded by the Press is obtained by the open display method, utilising banners for main streets, posters for hoardings and walls, and dwarf adhesive posters for the windows of shops and public transport vehicles. The posters should wherever possible be in colour, and they should carry a brief and stimulating message, together with a synoptic programme of events. The posters should find a place also in factories, railway and omnibus stations, theatres, cinemas, hotels and restaurants. Commercial firms are usually willing to display them on the sides of their delivery vans. Further open air publicity is offered by the use of loud-speaker or cine-motor vans which tour the principal streets broadcasting 'slogans,' and come to rest in side and suburban streets where they may submit short propaganda programmes with or without the aid of films. Information booths decorated by posters and housing supplies of leaflets, may with advantage be set up at key points. Advance notices should also be screened at local cinemas. Fruitful soil for health propaganda is furnished by the children's Saturday morning cinema clubs at which 5-minute talks on cleanliness and the like may be given, and simple questions asked. Children readily enter into the spirit of such meetings.

Schools. Health propaganda in schools during health week may be undertaken in one or all of four ways. First by the issue to each child of the official programme which is, as already noted, a health brochure containing the diary of events as a slip page. Teachers should take the opportunity to explain and underline the information which it provides. Next, by daily five-minute health talks to the children from their teachers. The talks should be of a simple character and illustrated whenever possible. The third method consists in the health 'quiz.' A list of questions is drawn up by the school medical officer, and prizes are offered for the best answers. There may if preferred be two lists, one for the under-elevens and one for senior children. Competition in such events is keen and the effort made in tackling the questions brings the lessons home. The quiz moreover provides a useful check upon the success of health teaching in school. The fourth method is provided by the school health exhibition, a simple type of display which is arranged by the children themselves. While it is an excellent method of fixing health facts in the children's minds, its value no less lies in the interest and instruction which it offers to parents and others who are brought by the children to see it. A short health play performed by the pupils may usefully round off the adults' visit.

Cinema Lectures should be arranged for the beginning and end of a health week. It is a good plan to devote the first meeting to general health and 'keep fit' topics and to reserve the second for a frank talk on venereal disease. The general principles applying to cinema propaganda, already stated, should be observed. Adequate time for written questions should be allowed, and the evening should terminate with a film in lighter mood. The event should be advertised nightly in the selected cinema and also in other local theatres during the week preceding the lecture. Attendances at such meetings have on the whole been good, the hearing attentive and the questions in most cases intelligent. The value of cinema shows which take the form of brains trusts is debatable, and they should be prompted only if the panel is guaranteed to hold the interest of the audience, and if the question master is adroit in guidance and apt in comment.

The **Health Exhibition** is a focal point of health week. It serves admirably as a rendezvous alike for the opening ceremony, for the short-time film projections, for brief topical lectures and for instruction on the conducted town plan. All that has been said above of health exhibitions in general should receive attention, particular stress being laid on the central location of premises, compactness of lay-out and brevity of captions.

Special **Meetings for Women** have enjoyed a full measure of popularity during health weeks. They should be held either in the health exhibition building or in some equally convenient premises. Each meeting should take the form of a short address by a medical member of the public health staff, or other practitioner, followed by questions on the theme of the day. Such topics as immunisation, dietetics, oral hygiene, juvenile rheumatism, the prevention of tuberculosis and the treatment of parasitic conditions are well received. The meetings should be fully advertised and it is an essential that the speaker should tackle the subject racily and appreciate the women's point of view.

The **Churches** can play an important part in furthering the crusade, if only by appropriate intimation of its events. Clergymen of all denominations should be invited to preach a health 'sermonette' based either on personal knowledge of the facts or on material supplied by the Health Education Councils. It has been found that many ministers are prepared to deliver a complete sermon on the moral aspects of health living, while most will undertake to make the cause known to the various organisations under their charge. Bible class and Sunday School teachers should also be invited to refer to the campaign and if possible to devote a short lesson to its meaning.

A **youth rally** can be one of the high lights of the health week. A large centrally situated hall should be engaged, possessing an adequate platform and with facilities for staging a programme for children to be sustained almost entirely by children. After a brief Chairman's address the proceedings should open with singing by combined school choirs, followed perhaps by one or two vocal or instrumental solos. Thereafter, a short address should be given by a speaker who can make an attractive appeal to the young. The audience, while primarily of children, is certain to contain many parents and youth leaders, and the address should cater for these also. The principal feature of the programme should now appear in the form of a health tableau enacted by the children. The presentation, if effective and accompanied by a vigorous commentary, can be at once instructive and entertaining.

Such a tableau, devised by one of us for health week in Edinburgh, and presented in mime, dealt serially with the letters of the word 'health,' illustrating the importance of Habits, Exercise, Attire, Leisure, Temperance and Happiness in the maintenance of fitness. The placards and simple stage properties, together with the bright costumes of the children, and the comedy of the action, did much to point the moral of the display. Children enter into such undertakings with zest and the efforts expended on production are fully repaid by the results.

The health play is a possible alternative to the tableau but requires considerably more rehearsal: and children's speaking voices do not always carry well in public halls which frequently have acoustic imperfections.

Should a health quiz or other children's contest have been organised in connection with the event, it is appropriate that the prize winners should receive their awards during the evening. The rally should end with the choir singing choruses in which the audience can join.

A series of **Open Air Displays** should be a prominent feature of every health week. Two performances daily in a public park or garden should be aimed at, each lasting just over an hour. Music and commentary can be relayed to the audience over loud speaker systems. The items which make the greatest popular appeal are country, national and folk dancing, and mass physical exercises by children. Periodically the open air doctor should come to the microphone to deliver a racy 5-minute health talk. Printed programmes containing health mottoes may with advantage be distributed amongst the crowds.

Talks to Factory Workers are worthy of trial during the week. They should be of the 'straight from the shoulder' variety, brief and topical, and should be given by a medical officer of the public health department, or other medical practitioner who can cope with some good natured heckling and be prepared to give frank answers to questions. The speaker should be primed in the various health services available locally, including their places and times of meeting and other relevant information. Experience has shown that it is inadvisable to attempt canteen talks during the service of meals. It is better to persuade the management to grant, say, 15 minutes during mid-morning or mid-afternoon. In addition to the exhibition of posters anent health week, and the distribution of leaflets and other literature, health 'flashes' may periodically be sent over the works broadcasting system during working hours.

The above and other activities constitute the programme for a comprehensive health week. It will readily be realised that intensive effort and careful planning on the part of the organisers are essential for success. It is difficult to estimate the cost of such undertakings. More than half of the expenditure is on printing and other publicity, while the hire charges for halls and cinemas are also heavy. Health week in

Edinburgh, with a population of 440,000, cost just under one penny *per capita*. Much however depends upon the scale of the enterprise. The measure of its success is the number of persons brought into contact with the campaign.

TABLE 43.

PUBLIC EDUCATION IN HEALTH

Suggested Four-Year Cycle for Borough

YEAR	MAJOR EVENT (SPRING)	CONTINUOUS PROPAGANDA (WINTER)		
		ADULTS	CHILDREN	ALL AGES
FIRST YEAR	HEALTH WEEK	CINEMA SHOWS. General Health. Tuberculosis. Rheumatism. Venereal Disease. Cancer.	Daily Health Talk in School. 3 Special Cinema Shows. Weekly Health 'Flash' in Cinema Clubs.	Routine Leaflet and Poster Campaign. Special Health Displays in Shops.
SECOND YEAR	YOUTH FESTIVAL	HEALTH LECTURES. Medical Services. Mat. and C.W. School Med Serv. Minor Exhibition. Mat. and Ch. Welf. School Med. Serv.	Daily Health Talk in School. Special Health 'Quiz' with Prizes.	Routine Leaflet and Poster Campaign. Health Poster Contest. Health and Fitness Classes.
THIRD YEAR	HEALTH EXHIBITION	CINEMA SHOWS. Service for Blind. Service for Disabled Rehabilitation. Infestation. Brains Trust.	Daily Health Talk in School. Central Health Tableaux Display.	Routine Leaflet and Poster Campaign. Minor Health Week Indoors.
FOURTH YEAR	ADULT SPORTS GALA	HEALTH LECTURES. Infec. Dis. Control. Immunisation. Nat. Health Serv. Nutrition. Brains Trust.	Daily Health Talk in School. Health Quiz Prizes. End of Term Health Plays.	Routine Leaflet and Poster Campaign. Intensive Health Drive in Factories.
FIFTH YEAR	AS FOR FIRST YEAR	As for First Year.	As for First Year.	As for First Year.

It is not advisable to promote a health week oftener than once in two or three years. During intervening years less ambitious health displays should be held so that public interest may not be allowed to flag.

It has already been emphasised that a true policy of health education must be based on the long-term plan. To this end it is necessary to prepare a programme which will ensure that there is one major health 'event' annually in each local authority area, and a series of lesser meetings throughout the year, in addition to the routine propaganda undertaken in clinics, in schools, in factories and amongst the public by means of poster, Press and radio. The major event may take the form of a health week, a health exhibition or a youth festival, comprising athletics and health tableaux, or a sports gala at which the health aspect of games is stressed. In all cases the health motive must be paramount. During the winter months cinema lectures and public meetings or brains trusts should be promoted at which frank discussion and questions are possible. The school health quiz should be developed both as a means of interesting the children in health matters by introducing the competitive spirit and as a test of the efficiency of health teaching. The publicising of health facts by leaflet, poster or the Press should never be relaxed, and in this connection it is a sound investment to enrol the finest exponents of poster artistry and the cartoon in the cause. The Press side of the campaign must be developed to a much greater extent than hitherto by means of regular short articles, health competitions and other features, and general publicity for local and national health news. When we have persuaded editorial staffs of the incalculable benefits to the cause of health which well organised newspaper publicity can afford, we shall have taken a giant step forward. Table 43 suggests a possible sequence of events in the health education scheme for a large borough. The scheme will of course require modification to suit the type of borough concerned. It should not in any event be too ambitious. In cases of difficulty, the expert guidance of the appropriate Council for Health Education should be sought.

XXIII.

METEOROLOGY

THIS meteorological Section is put here as a prelude to Section XXIV which follows. The subjects with which it deals are Pressure and Winds. Both have much to do with the classification of climates in Medical Climatology.

PRESSURE

Atmospheric pressure is the force exerted on any surface by the column of air having its base on that surface and its summit at the limit of the atmosphere.

Barometers

When a glass tube about 33 inches long, closed at one end, is filled with mercury, and inverted with its lower and open end in a cistern containing mercury, part of the mercury runs out into the cistern, creating the Torricellian vacuum at the top of the tube. The pressure exerted by the column of mercury in the tube above the level of the mercury in the cistern balances the pressure exerted by the column of air having its base upon the mercury surface. The mercury column is an index of the pressure of the atmosphere, rising in the tube when air pressure increases and falling as it declines. The tube and cistern, with the mercury which they contain, are the essentials of a mercurial barometer.

Mercury is the medium of election for barometers containing liquid. Its high density gives a convenient column of some 30 inches, as contrasted with some 34 feet for a water barometer. Owing to its opacity its level is easily read. Owing to its low vapour pressure at ordinary temperatures the Torricellian vacuum is nearly perfect.

The aneroid barometer is a partially exhausted metallic drum the ends of which, supported by springs, respond to varying air pressures. Owing to imperfect elasticity in the springs the instrument is subject to permanent change of zero and so requires to be regularly adjusted by comparison with a mercurial barometer.

Pressure Unit

The unit of force on the C.G.S. system is that which produces an acceleration of one centimetre per second per second in a mass of one gram. It is called the dyne. The C.G.S. unit of pressure is the chemical bar, which is one dyne per square centimetre. The unit of atmospheric pressure is the meteorological Bar of one million dynes. The millibar, which is the working meteorological unit, is the thousandth part of a Bar. It equals a pressure of 1000 dynes per square centimetre.

The millibar is approved for general purposes by the Meteorological Office. The principal advantage of using it is that being itself a unit of pressure it does not require to be qualified by any reference to the temperature of the mercury or the local force of gravity. Thus the value adopted for mean pressure at sea level in North-West Europe is completely stated as 1013·2 millibars. Using a linear notation the equivalent value would be 760 mm., or 29·92 inches, of mercury as at the freezing point of water and in latitude 45°.

Kew Pattern Barometer

Cistern error is the change of the zero of the barometric scale produced by the rise and fall of the level of mercury in the cistern as the mercury in the tube falls and rises. In the Kew Pattern Barometer this error is adjusted in the cutting of the scale, the divisions of which are made smaller for the higher readings and larger for the lower. The Kew Pattern Barometer graduated in millibars is used by the Meteorological Office. Each instrument is certified by the National Physical Laboratory. The certificate shows the index errors, or errors in graduation of the scale.

The K.P. Barometer is standardised for temperature. The standard temperature, at which the barometer is made to read correctly, is 285*a*, equal to 12° C. or 53·6° F. Standardisation is required for latitude also. The standard latitude, at which the barometer is made to read correctly, is 45°.

The barometer is read with the aid of a vernier, which is a graduated slide attached to the scale, so marked that each vernier division differs by a known length, known as the difference, from corresponding divisions of the scale. The vernier division is usually the smaller. If a vernier having 10 divisions coincides with the scale for a distance of 39 mb, 4 divisions on the scale will equal 4 mb, and one division on the vernier will equal 3·9 mb. The difference therefore is 4—3·9 mb.=0·1 mb. For using the vernier the directions are to read the scale division next below zero of the vernier, and add to this value the difference as above defined, multiplied by the number of the vernier division which coincides with a division of the scale. In Fig. 200, showing a millibar scale with vernier, zero of the vernier coincides with a scale division,

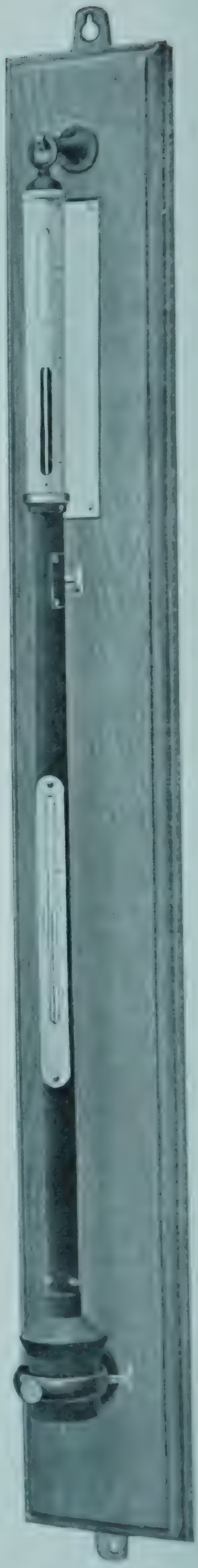

Fig. 199.—Kew Pattern Barometer.

and the reading is 985·0 mb. exactly. In Fig. 201 the scale division next below zero of the vernier is 1012[1]: the number of the coinciding vernier division is 7 and the difference is 0·1 mb. The barometer as read, written B.A.R., is 1012 + 7 × 0·1 = 1012·7 mb.

In making a barometric observation the correct procedure is first of all to read the attached thermometer, next to see that the barometer is vertical, to tap it lightly with the pads of the fingers to ensure mean capillarity, and then to set the vernier and read it. If reduction of the reading to mean sea level is required, the temperature of the air, as shown by the dry bulb thermometer in the screen, must be ascertained.

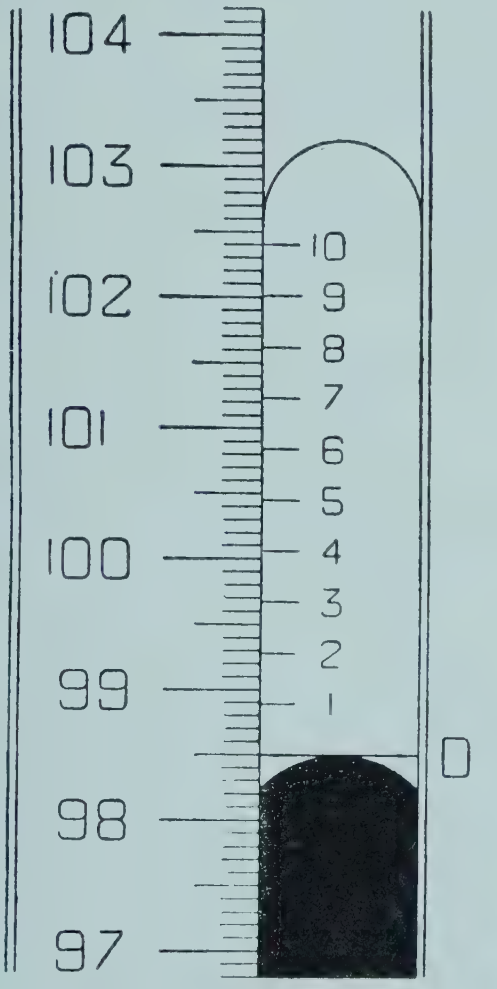

Fig. 200.—Barometer as Read, 985·0 mb.

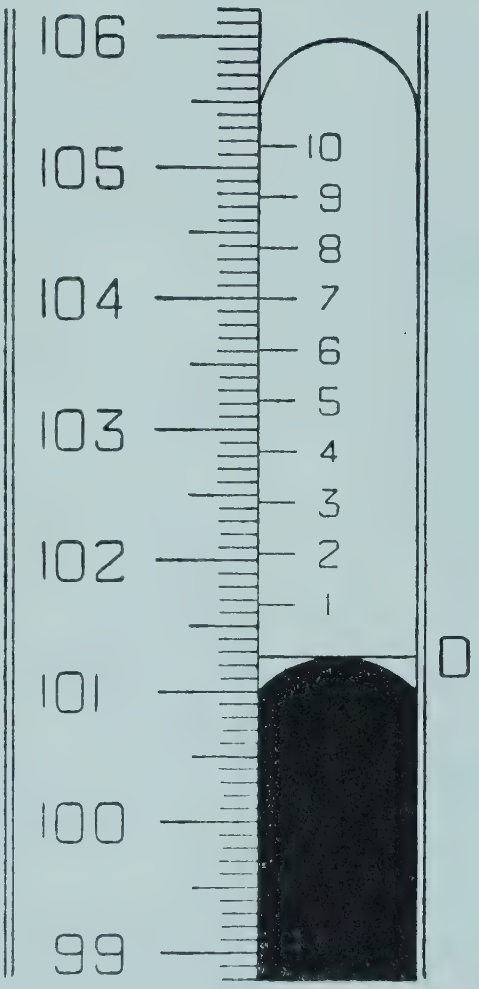

Fig. 201.—Barometer as Read, 1012·7 mb.

The barometer as read requires to be corrected for index error, temperature, latitude and usually elevation. The correction for index error is obtained from the certificate of the National Physical Laboratory. The corrections for temperature, latitude and elevation are derived from official tables published by the Meteorological Office.

Fortin Barometer

The Fortin Barometer differs from the K.P. Barometer in its method of correcting cistern error. Zero is fixed, coinciding with a fixed index called the fiducial point which is usually made of ivory. Before taking an observation the surface of the mercury in the cistern is made flush with the ivory point by screwing the plunger (Fig. 202) at the base of the cistern till the ivory point is exactly coincident with its image in the mercury. In other respects procedure corresponds with that for the K.P. Barometer.

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[1] 101 on the scale means 1010. The terminal zeros are omitted from the values as engraved on the instrument.

Pressure Variation

Mean pressure at sea level in the British Isles is taken as 1013·2 mb. The highest pressure recorded in Britain is 1053·5 mb., and the lowest 925·5. A diurnal variation of pressure occurs with two minima about 4 A.M. and 4 P.M. and two maxima about 10 A.M. and 10 P.M. It is ascribed to two pressure waves related to the earth's rotation. A seasonal variation of pressure takes place in mean latitudes, in the sense that over continental areas pressure is low in summer and high in winter, while over the sea the reverse conditions hold. In summer the great land areas grow warm and the hot air spills away from over them to be heaped up over the cooler sea. In winter the great land areas grow cold, and air from the relatively warmer sea is then heaped up over them.

Pressure in the atmosphere decreases with height. For low altitudes the lapse rate is roughly 30 mb. per 1000 feet of ascent. The Altimeter is an aneroid barometer graduated to show height. It is employed in practice to give an indication of the heights of mountains.

Taking pressure at sea level as 1013·2 mb., pressure at 3½ miles, or 18,000 feet, would be in the neighbourhood of 500 mb.: at 34 miles it would be about 1 mb.

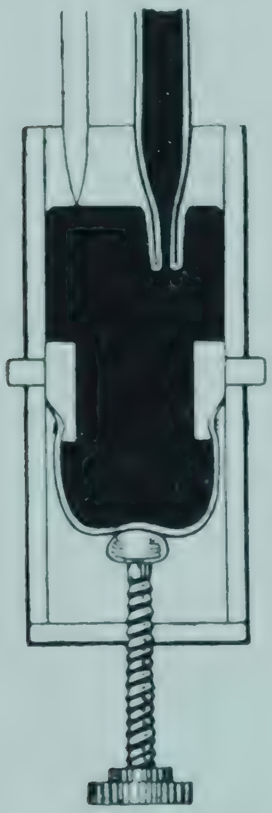


Fig. 202.
Cistern of Fortin Barometer.

Isobars

When pressure values are plotted on a map Isobars, or lines of equal pressure, can be drawn through points of equal value. In order to discount that part of the variation which is due merely to altitude the pressures are reduced to mean sea level, and when so reduced display a general tendency to follow the parallels of latitude. According to the distribution of the world isobars regions of high and low pressure are recognised as in Table 44.

TABLE 44.

WORLD PRESSURE REGIONS

Region	Mean Pressure	Latitude
North Pole . . .	High	90° N.
Arctic	Low	66½° N.
Horse Latitudes N. . .	High	35° N.
Equator	Low	0°
Horse Latitudes S. . .	High	30° S.
Antarctic . . .	Low	66½° S.
South Pole . . .	High	90° S.

The Polar Highs are caps of high pressure in or close to the position of the North and South Poles respectively. In the Horse Latitudes North the mean high pressure is made up by three pressure centres over the North Pacific, Azores and Siberia. The first two are high only in summer, and the last only in winter. In the Horse Latitudes South there are three centres over the South Pacific, South Atlantic and Indian oceans, all of which are relatively high both summer and winter.

Altogether, the seven regions show an alternating arrangement of high and low pressure belts, four being of mean H.P. and three of mean L.P. The scheme is diagrammatically set forth in Fig. 203.

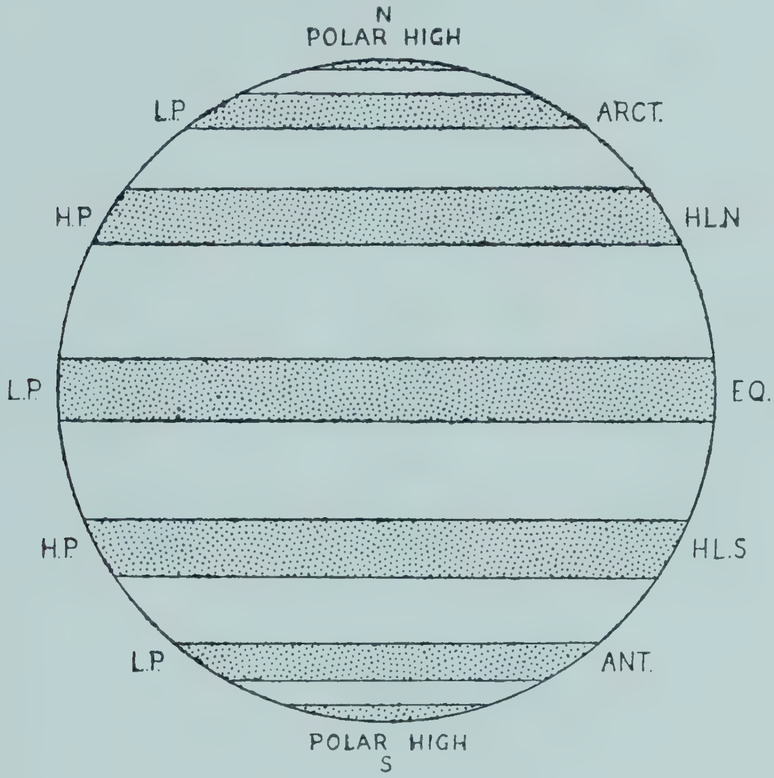


Fig. 203.—World Pressure.
Diagrammatic.

N.	North	ARCT.	Arctic.
S.	South.	ANT.	Antarctic.
L.P.	Low Pressure.	HLN.	Horse Lat. N.
H.P.	High Pressure.	HLS.	Horse Lat S.

WINDS

Wind is air moving more or less horizontally near the surface of the earth. Difference of density of the air produced by difference of temperature is the ultimate factor in the production of wind.

Winds are named according to the quarter from which they blow. Direction may be given by compass points, true not magnetic. When direction is specified in degrees from 0° to 360°, E. becomes 90°, S. 180°, W. 270° and N. 360°.

The simplest direction indicator is a pennant on a flagstaff. A vane, where employed, should be light, rigid and sensitive. More elaborate arrangements are made use of in autographic recording instruments.

The direction of wind currents at high levels is observed by means of pilot balloons. These are hydrogen-filled indiarubber balloons 2 or 3 feet in diameter, which are liberated to drift with the wind, and kept in view through the telescope of a theodolite.

Wind Velocity

The velocity of the wind is measured by means of Anemometers, of which the pressure-tube and cup types are mainly used in this country.

The *Pressure-tube Anemometer* consists of two tubes, an inner and an outer. The nozzle of the inner tube is kept facing the wind by a vane, so that the air in the tube is under positive pressure. The outer tube ends above in four rows of perforations, across which the wind blows, producing negative pressure inside the tube. The tubes are led down to the recording apparatus, which is an inverted float contained in a closed water-charged cylinder. The positive pressure tube terminates inside the float, the negative pressure tube in the containing cylinder. As the force of the wind waxes and wanes the float rises and falls, and its movements are transmitted by a metal arm and pen to a revolving drum. The record may be expressed in terms of wind pressure or velocity.

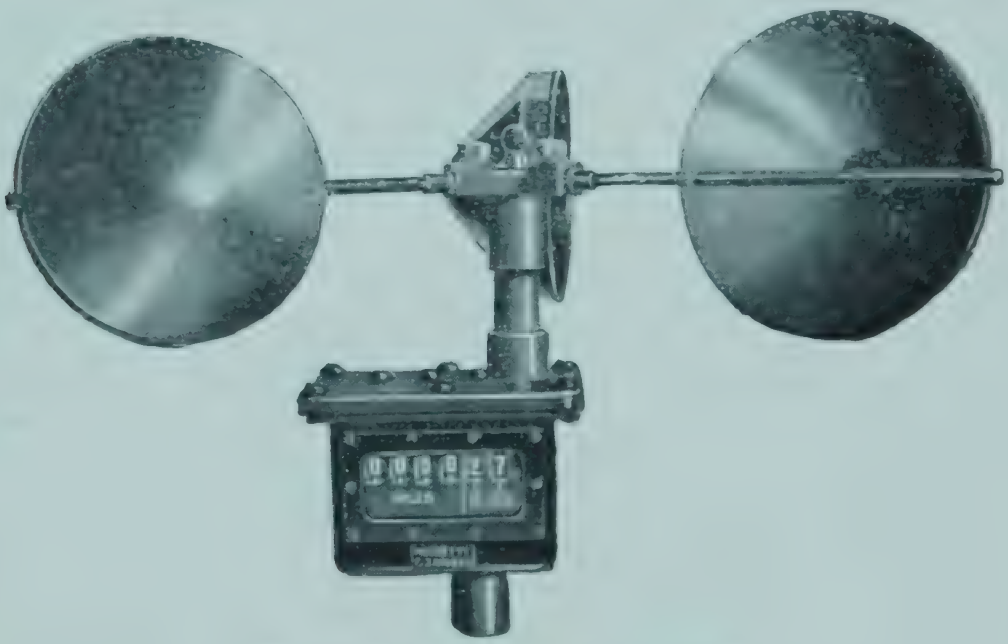


Fig. 204.—Cup Anemometer.

The *Cup Anemometer* (Fig. 204) has three conical cups, 5 inches in diameter, with beaded rims and detachable metal arms. The movement is transmitted by a steel spindle to a counter mechanism reading to 10,000 miles. The ratio of the distance travelled by the wind to the distance travelled by the cups is known as the factor of the anemometer: this factor is 2·5 and is allowed for in the calibration of the instrument.

The run of the wind during the interval between two successive readings, 12 or 24 hours as the case may be, may therefore be found by subtracting one from the other. If the instrument is placed in a position where access cannot be readily obtained, the dial can be read at a distance with the aid of binoculars. Four-cup anemometers are used also.

The *Air Meter* is best for light airs in the open or air currents in the outlets or inlets of rooms. It is a fan with light metal blades and a recording dial.

Wind velocity has in general a constant relation to wind pressure

The pressure tube anemogram is graduated both in metres per second and millibars. Velocity may be expressed in miles per hour, feet per second or metres per second.

Beaufort Scale

The Beaufort scale of wind force and velocity was introduced by Admiral Beaufort in 1805. It was originally stated with reference to the canvas which could be carried by a warship of the day. Revised specifications for use on land have been drawn up by the Meteorological Office.

From the Beaufort number wind velocity is derived by the formula

$$V = 1{\cdot}87\sqrt{B^3}$$

where V is the velocity in miles per hour and B is the Beaufort number. Wind pressure is calculated from the formula

$$P = 0{\cdot}0105B^3$$

where P is the pressure in pounds per square foot.

Table 45 shows the latest specification of the Beaufort scale with

TABLE 45.

BEAUFORT SCALE

Beaufort Number.	Explanatory Title.	Specification for Use on Land.	Speed in Miles per Hour, at Elevation of 33 ft.
0	Calm	Smoke rises vertically	Less than 1
1	Light air	Direction of wind shown by smoke drift but not by wind vanes	1-3
2	Light breeze	Wind felt on face; leaves rustle; vanes moved by wind	4-7
3	Gentle breeze	Leaves and small twigs in constant motion; wind extends light flag	8-12
4	Moderate breeze	Raises dust and loose paper; small branches are moved	13-18
5	Fresh breeze	Small trees in leaf begin to sway; crested wavelets form on inland waters	19-24
6	Strong breeze	Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty	25-31
7	Moderate gale	Whole trees in motion; inconvenience felt when walking against the wind	32-38
8	Fresh gale	Breaks twigs off trees; generally impedes progress	39-46
9	Strong gale	Slight structural damage occurs; chimney pots and slates removed	47-54
10	Whole gale	Seldom experienced inland; trees uprooted; considerable structural damage occurs	55-63
11	Storm	Very rarely experienced; accompanied by widespread damage	64-75
12	Hurricane	... ...	Above 75

equivalents of the numbers. The wind velocities are all at an elevation of 33 feet in the open.

Planetary Winds

Near the surface the air flows out from the high to the low pressure belts of the world. If the earth were stationary the resulting winds would be either due north or due south, blowing directly along the meridians. With the earth rotating from west to east, they are, in terms of the law of deflexion, deflected to the right in the northern hemisphere and to the left in the southern. Hence the winds from the north polar high, so far as explored, blowing towards the Arctic low, begin as north winds and become north-easterly. The winds from the horse latitudes N., blowing towards the Arctic low, beginning as south winds, become south-westerly, and are known as the westerlies N. The winds from the horse latitudes N., blowing towards the equator, beginning as north winds, become north-easterly, and are known as the north-east trades. The corresponding winds in the southern hemisphere are the south-east trades, the westerlies S., and, so far as explored, the south-easterly wind from the south polar high. These six wind systems are the planetary winds, as shown in Fig. 205.

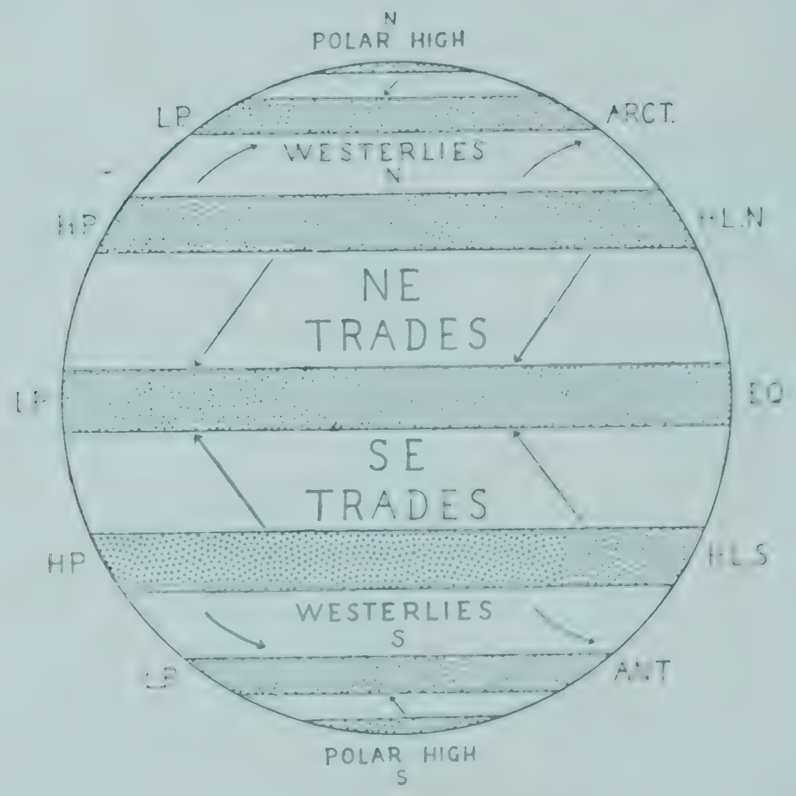


Fig. 205.—Planetary Winds.

N.	North	ARCT.	Arctic.
S.	South.	ANT.	Antarctic.
L.P.	Low Pressure.	HLN.	Horse Lat. N.
H.P.	High Pressure.	HLS.	Horse Lat S.

The north polar easterlies have been traced in Greenland and Alaska. The westerlies N. are inconstant in the North Pacific, but more constant in the North Atlantic, whence they produce a prevalence of westerly winds in the United Kingdom. The westerlies S. are strong and steady. They blow untrammelled over the sea between latitudes 40° and 50° S.

which are called by sailors the Roaring Forties. The trade winds, though subject to interruptions, are in general very constant. The north-east trade has a mean velocity of 10½ miles per hour and the south-east trade of 14.

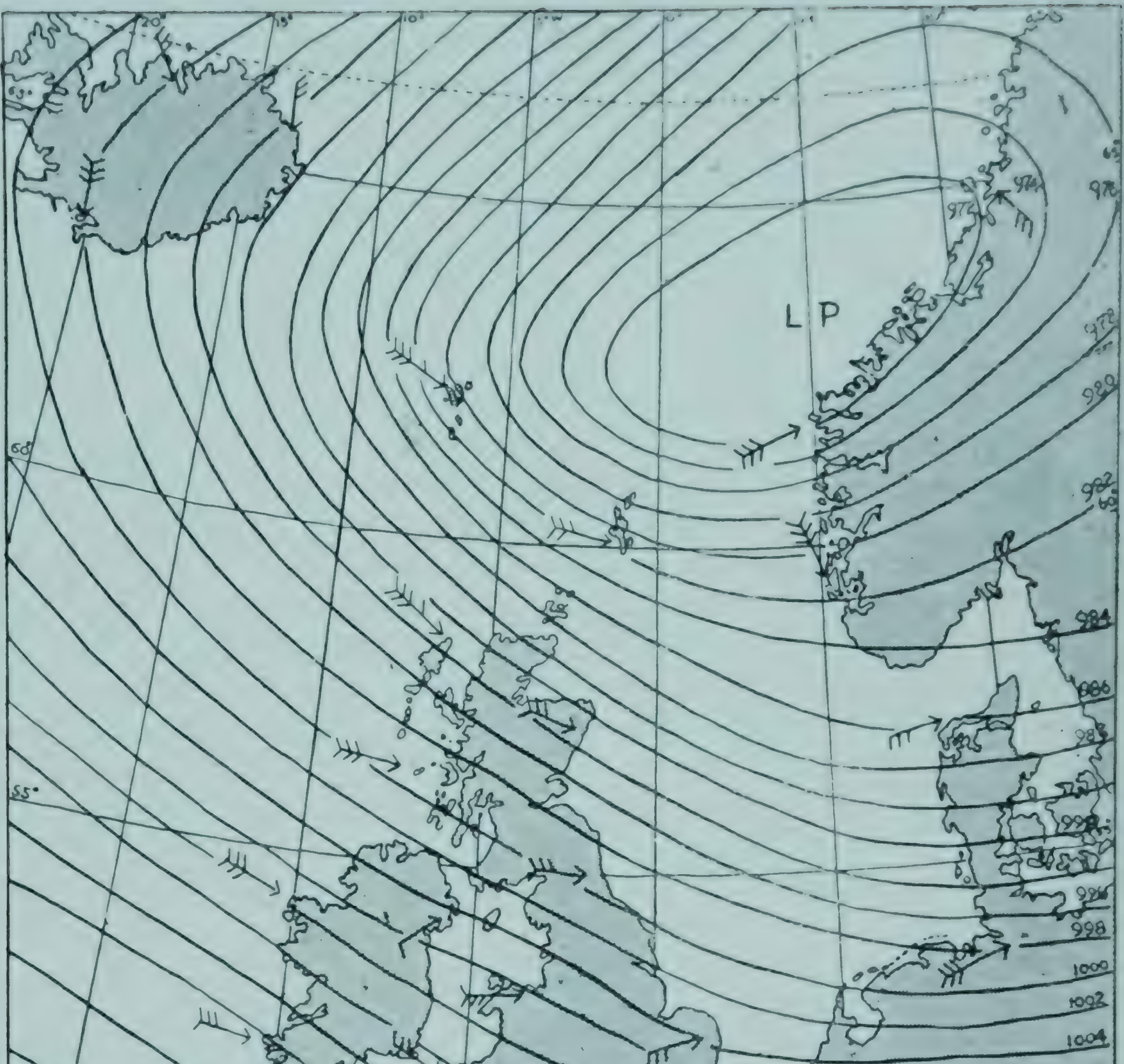
Each planetary wind is the one-way movement of a system of air exchange. The systems north and south of the equator, to which the north-east and south-east trades belong, are thermally conditioned. When air is heated at the equator, it expands, grows lighter and rises. Part, remaining over the equator, loses relative rotary velocity, and, lagging, becomes the high easterly equatorial drift, which in 1883 carried the dust of Krakatoa round the world. Part spills away north and south, is deflected to form the south-west and north-west anti-trades above the north-east and south-east trades, and finally becomes the westerly current over the horse latitudes N. and S. whence it sinks to feed the trade winds and so back to the equator. As the outgoing air takes a high path while the returning air is at surface level, the circulation between the equator and the horse latitudes is on the whole smooth and orderly. The exchanges between the horse latitudes N. and S. and the Arctic and Antarctic lows, all of which take place at surface level, are more tumultuous. Thus the westerlies N., moving out northerly at surface level, keep pouring air into the Arctic, and the overflow, which must return at surface level, has to force its way back against them. The returning cold air presents the polar front which is the cradle of our cyclones.

Cyclones

Strong winds in the United Kingdom are frequently associated with the passage of a cyclone, depression or low, as it is variously called. The mature cyclone is a circular or oval formation of closed isobars with the lowest pressure in the centre and the highest at the periphery. Were the earth stationary the peripheral air would move directly towards the centre. Owing however to the earth's rotation the law of deflexion comes into play and the winds blow round the centre of low pressure, counter-clock in the northern hemisphere and clockwise in the southern. The pressure gradient of the cyclone is the rate of change of its pressure with distance. It is inversely proportional to the distance between the isobars, measured at right angles to them. When the isobars lie close together the gradient is steep and the winds are strong, and *vice versa*. For the average cyclone in mean latitudes the gradient is about 5 mb. per degree of a great circle: for an intense depression 15 mb. The diameters of cyclones range from 100 miles or so upwards. A thousand miles is an average figure. The speed of advance may be 20 miles an hour.

Origin

The cyclones of the northern hemisphere originate, for the most part, on the polar front of southward thrusting air, the normal line of which should run east and west about the latitude of Iceland. Owing


L P
H P
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1008
1012
1014
1016
1018
1020
1026
20°
15°
10°
60°
55°
50°
45°
5°W
0°
5°E

Fig. 206.—Cyclone. Centred off Norway.

Pressure of isobars is marked in mb. at right-hand margin. Centre at LP shows pressure 972 mb. Outer isobar near HP has 1026 mb. Arrows fly with the wind. The number of their feathers gives their Beaufort number.

however to the irregular distribution of land and sea the Arctic cap of cold air assumes the form of a figure-of-eight, putting out one great salient over Northern Canada and Greenland and another over Siberia. Along the eastern edges of these projecting tongues, where the Arctic air meets the warmer westerlies, the cold and warm airs strive together, producing atmospheric disturbances which develop into the cyclones of the North Atlantic and North Pacific.

The North Atlantic cyclones come to Western Europe, launched, it may be, in families of four, making 66 families or so per annum. They pursue a variety of courses. Many move in the line of the westerlies, their centres passing to the north-east between Scotland and Iceland. Their southern fringes, which sweep the United Kingdom, cause a prevalence of south-westerly winds. Centres of cyclones usually keep to sea routes. If they cross the land, they do so in general at low lying places.

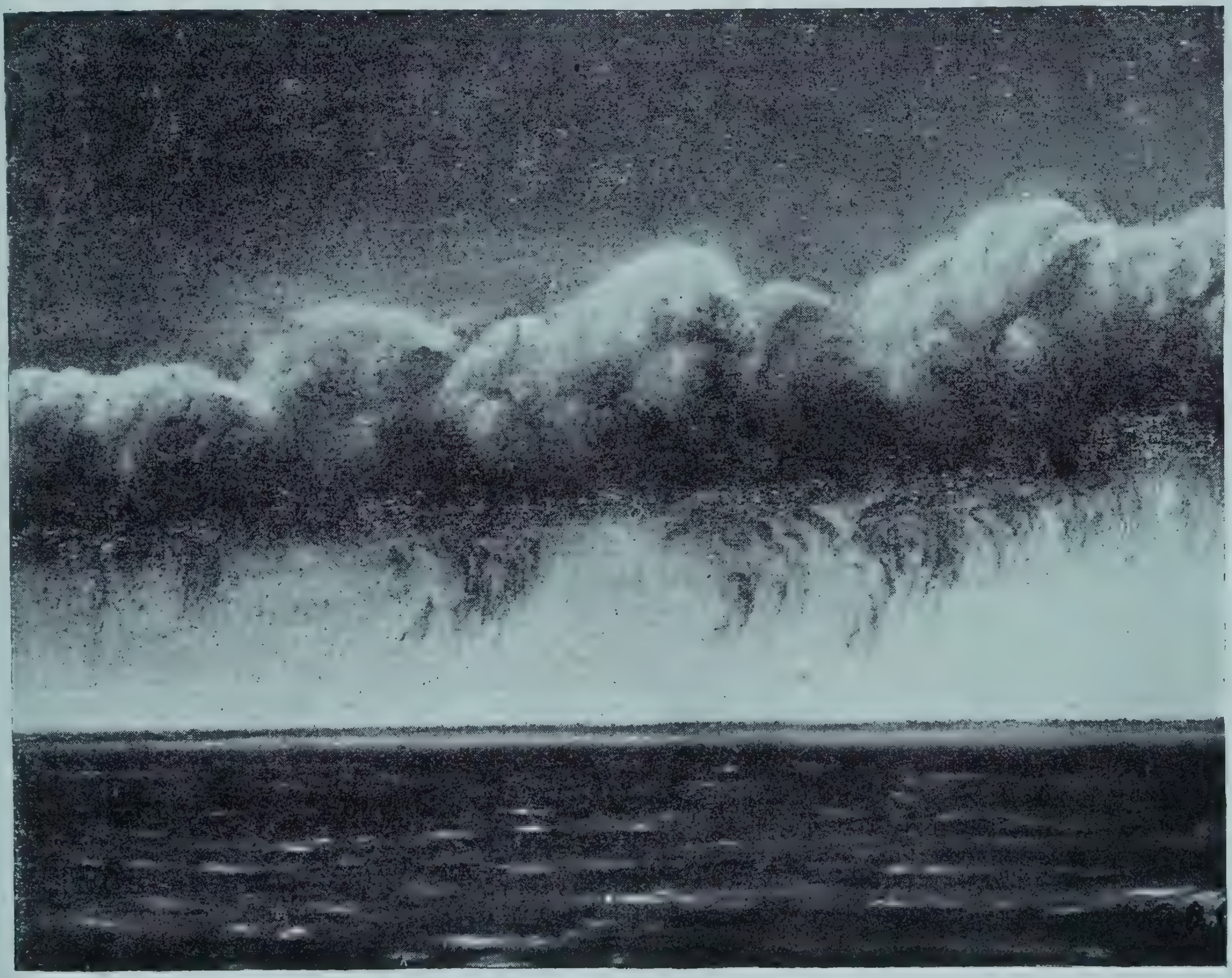

Fig. 207.—Line Squall over North Sea at Aberdeen.

Tropical Cyclones

Compared with the cyclones of mean latitudes, tropical cyclones are of similar structure but smaller size. They may measure from 10 to 50 miles across. They have steep gradients and winds of great violence. They are called cyclones in the Indian Ocean, typhoons in the China Sea and hurricanes in the West Indies. Tropical cyclones beginning in the West Indies or south of the Azores high have been traced on occasion across the Atlantic to Great Britain. They behave on arrival with the comparative mildness of cyclones proceeding from the polar front.

Tornados

Tornados are travelling vortices of air set in motion on hot summer afternoons by the heating of the lower layers of the atmosphere on flat lands like those of the Mississippi valley. Tornados, though not of cyclonic structure, are popularly known as cyclones in the United States. They may advance at the rate of 40 miles an hour. Their diameter may be as little as 100 yards. The destruction in their path is usually complete. *Waterspouts* at sea are of the same nature as tornados: so also are the *Simooms* of deserts, which cause death by heat stroke.

Line Squalls

A line squall is produced by a sudden shift of wind, as at Aberdeen (Fig. 207) in October, 1912, when a cold squall from W.N.W. undercut warm air from S.S.W., thrusting it up to form a line of dark cloud which stretched across the sky. The squall was attended by sharp showers and blew windows in. The V-shaped depression, which is a tongue of low pressure intervening between two highs, also exhibits line squall action. It became notorious in this country through the loss of H.M.S. *Eurydice* off the Isle of Wight in 1878.

The *Pamperos* too, of the Argentine and Uruguay, are of the line squall type.

Local Winds

Land and sea breezes furnish an instance of the direct effects of diurnal heating and cooling. They occur in nearly all latitudes but are most regular in the tropics. The sea breeze blows by day, beginning about 10 A.M. It brings air from the sea to replace warm air rising from the heated land. The land breeze blows at night, from about 8 P.M., conveying air from the rapidly cooling land to the more slowly cooling sea.

Monsoons are produced by seasonal heating and cooling. In India in the hot weather the whole land is heated till the strong wet south-west monsoon sets in from the sea to land, reversing the north-east trade. In the cool weather, as the land cools, the weaker dry north-east monsoon blows from the land to sea. The monsoon winds have a wide range in the Orient, and may be traced also to some extent in Equatorial Africa and Spain.

The *Bora* is a cold wind cascading down on the Adriatic and Dalmatia from high plateaux to the north. The dry cold air has a parching effect. The force of the wind is great, and streets in towns are provided with guy ropes for the safety of pedestrians. The *Tramontana* is a similar wind on the western shores of the Adriatic, and the *Mistral* on the Riviera.

The *Sirocco* blows from the south in front of a depression moving eastward along the Mediterranean. Leaving Africa it is hot and dry, and charged with dust from the Sahara. As it crosses the Mediterranean it becomes moisture laden and reaches Italy as a warm wet wind. The *Harmattan* is a parching wind blowing from easterly off the Sahara and carrying the desert dust far out into the Atlantic. On the north coast of the Gulf of Guinea it is felt as a cooling wind. The *Khamsin* in Egypt is a hot desert wind. A. W. Kinglake commented on its steadiness.

Föhn is the name given to a wind which has crossed a ridge of the Alps from the south. The air as it ascends the southern slope expands through falling pressure, cools and throws down its moisture. After topping the ridge it passes down by eddy-convection into the northern valleys, being now a dry dynamically warmed wind of an unpleasant kind.

The *Chinook* is a similar warm dry wind descending on the central plains of Canada from the Rocky Mountains, on the high slopes of which it has left its sea-derived moisture.

XXIV.

MEDICAL CLIMATOLOGY

THE classification of climates here adopted is primarily based upon the high and low pressure belts of the world (Figure 205), and the planetary winds which blow between them. There are two belts of high pressure, the horse latitudes N. and S., the former situated round 35° N. and the latter round 30° S. There are three belts of low pressure, one on the equator known at sea as the doldrums, and two on the polar circles, known respectively as the Arctic and the Antarctic low. From the high pressure horse latitudes N. the westerlies blow out towards the Arctic low, and the north-east trades blow out on the other side towards the equatorial low. In the same way the horse latitudes S. provide the westerlies S. and the south-east trades. The caps of high pressure over the North and South Poles do not concern Medical Climatology.

On this plan, as set forth in Fig. 205, there exist the paired polar zones Arctic and Antarctic: the paired westerly zones N. and S.: the paired horse latitude zones N. and S.: the paired trade wind zones N.E. and S.E.: and the unpaired equatorial zone. In order that allowance may be made for the influences of land and sea these five zones are next cross-divided as continental and marine. When the last two groups have been further sorted out, the continental into plain, plateau and mountain and the marine into oceanic, east coast and west coast, the scheme of Table 46 emerges for the climates of the world:

TABLE 46.
WORLD CLIMATES

ZONES	CONTINENTAL			MARINE		
	Plain	Plateau	Mountain	Oceanic	East Coast	West Coast
Polar . . .	...	...	...	...	...	...
Westerlies . .	...	...	...	...	...	...
Horse Latitudes .	...	...	...	...	...	...
Trade Winds .	...	...	...	...	...	...
Equatorial . .		...	...		...	...

Taking the climate of Britain as an example, we can see that its proper place is opposite 'Westerlies,' and under 'West Coast.' 'Westerlies' tells us that the prevailing winds are from westerly.

'West Coast' tells us that they blow on-shore, bringing up wetness from the Atlantic. We deduce that the climate should be moist and on the whole equable, and such, allowing for seasonal change and the occurrence of cyclones, it may be admitted to be.

In the following pages the purpose is to indicate without elaboration the influence of the climates in promoting the vigour and health of Man or on the other hand, breeding conditions of lassitude and disease. The various climatic types will be dealt with in order: I. the Zone types: II. the Continental types: and III. the Marine types.

I.

ZONE TYPES

The zone types of climate have well marked differential characters. Extending as they do from the equator to the poles, they exhibit a range of variation as wide as the world itself. They are entitled (1) polar, (2) westerlies, (3) horse latitudes, (4) trade winds and (5) equatorial.

Polar

The Arctic embraces Lapland, Spitzbergen, the tundras of Siberia, Greenland and the North of Canada. It is mainly inhabited by Lapps and Eskimos. As the Arctic Ocean is under ice, there is, so far as climatic features are concerned, less difference between sea and land in the Far North than elsewhere.

The frigid polar air is normally near saturation, as is evidenced by the ice particles with which it often fills. Nevertheless its absolute humidity is low, so that the moisture of the breath has to be maintained by excess withdrawal of water from the body. Persistent thirst is thus a feature of life in the Arctic. The appetite too is keen owing to the stimulating effect of the cold on tissue metabolism, and a craving for fat and sugar is usual. The Eskimos appear to derive a sufficiency of carbohydrate from such sources as berries and moss, and the glycogen in the skin of young whales or the liver and muscles of animals. The low temperatures of the Far North are bearable if the air is still, but if the cold air is moving precautions must be taken. Woollen clothing covered by a wind-proof textile has been found effective by explorers. Visitors to the Arctic in summer have felt the incessant daylight vexatious. The long night may in some depress the mind and induce aberration.

Among the afflictions of man in the Arctic are (1) scurvy, (2) frost bite, (3) cold stroke and (4) snow blindness.

Scurvy is occasioned in the Arctic as elsewhere by the deprivation of fresh food. Hardship alone will not induce it, for when *Endurance* was crushed in the ice some of her crew who took to an ice floe subsisted on seals, penguins, limpets and seaweed without contracting the disease. In the Swedish Norrland protective power against scurvy is accredited to cloudberries and similar presumed sources of vitamin C. The disease in the North has the special demerit of predisposing to frost-bite.

Frost-bite principally affects the extremities or the nose, ears and cheeks. Its initial signs are failure of sensation and pallor of the part. In this early stage the lesion should be treated by gentle rubbing, first with snow and next with cold water, and then wrapped in cotton wool but no heat applied. If gangrene develops the environment should be one of warm dryness.

Cold stroke is most apt to occur in persons reduced by illness, weak with fatigue or hunger or improperly clad. The premonitory symptoms are dimness of vision and heaviness of the limbs. Torpor follows with intense drowsiness. The treatment consists in wrapping the patient in blankets and causing the temperature of the air which surrounds him to rise slowly to comfort level. When he begins to revive it is useful to administer alcohol.

Snow blindness is attended by pain in the eyes, conjunctivitis, lacrimation and photophobia. It was at one time ascribed to eye strain produced by the glare of bright sunshine reflected from snow, but is now believed to be due to the inadequate illumination of the snow track along which the traveller stumbles when the sky is overcast. The dull diffused light throws no black shadows to bring objects into relief, and the eye tires in the vain endeavour to distinguish heights from hollows. The same optical complication occurs in the so-called 'white dark' when the air is thronged with ice crystals. Well fitting goggles of yellow-tinted glass are a defence against snow blindness. The lenses should be triangular in shape and have enclosing side-pieces. Slotted wooden goggles are used by the Eskimos. Relief of symptoms is effected by the use of zinc sulphate solution and the instillation of cocain.

As regards the infections of the Arctic, typhus fever and pneumonia may occur there as in other zones. Leprosy has lingered in the North but is dying out. Tuberculosis, introduced into Greenland along with the comforts of civilisation, has found in the people a virgin soil and caused a high mortality. If it be the case, as held by some, that the Norse settlements in Greenland were extinguished by the Black Death in 1349, plague can invade the Arctic. Rheumatism on the other hand is not favoured by high latitudes: it is reported to be uncommon among the Eskimos.

Though the conditions above described are typically polar, the whole Arctic region is not constantly under the tyranny of cold. Unusual influxes of warm southerly air, especially in late summer, may produce spells of pleasant weather with high day temperatures well within the Arctic circle.

The ice-capped Antarctic continent is bitterly inhospitable. In Adelie Land the average velocity of the prevailing wind is 50 miles an hour, with gusts up to 180. There are no indigenous dwellers in this inclement waste.

Westerlies

In the Westerly Zone N. are the British Isles, France, the Low Countries, Denmark and the central belt of Europe, part of Siberia, the northerly half of the United States and the organised tract of

Canada. Japan, though geographically in the westerlies, has a monsoon climate.

In Britain, which enjoys a typical westerly climate, the prevailing breezes from the west and south-west are not too tediously steady, for the cyclones formed in mid-Atlantic, especially in winter, are apt to break in with boisterous weather, veering winds and heavy rain. The westerly breezes are tonic. By promoting evaporation from the surface of the body they stimulate metabolism. The cyclonic gales carry health and vigour: they drive fresh air into houses, and the rain-storms wash the ground clean. The temporarily overcast skies enhance the vivifying activity of the solar rays when clear weather returns. Under such conditions prolonged intense heat or cold is exceptional, so that no uninterrupted strain is imposed on the vital organs.

It has thus been claimed that the climate of the westerlies is the best of all for Man. Not only, as noted above, does it key up his physical forces: it quickens his power of mind. The frequent gray days, it is said, are conducive to mental concentration for which blue unclouded weather, whether it be hot or cold, would be unsettling. The four seasons of the westerlies possess distinctive characters. In the dawn of time they taught primitive man when to sow, when to reap and when to lay up stores for the winter. Labour had to be planned. Forethought was encouraged and character formed. Some of the dominant races of the world to-day were nurtured in North West Europe by the Westerlies N.

The westerlies climate, when attended by cold humid winters, fosters respiratory disease, rheumatism and addiction to alcohol. Pneumonia, bronchopneumonia and bronchitis are brought on by temperature changes from warm to cold, and bronchitis, once initiated, tends to assume the chronic form owing to constant or repeated exposure to fogs or raw winter air. Rheumatism is engendered in a damp cold environment, amply provided during winter in Britain which receives its westerly winds direct from the sea. From the same unfriendly atmosphere, when days are short and skies gloomy, alcohol holds out to some a fleeting promise of escape.

The influence of climate is apparent also in the seasonal incidence of the infectious diseases endemic in the westerly zone. The cold time of the year leads people to seek comfort indoors, where their increased propinquity shortens the path of the spray-borne infections. Hence cerebrospinal fever, encephalitis, measles, smallpox and whooping cough are in Britain mainly diseases of winter or early spring. Typhus fever also exhibits its seasonal peak in this period, for when verminous persons crowd together for warmth the infected lice change hosts. Early autumn is the time of election for infantile diarrhoea and poliomyelitis. The former is doubtless aided by an abundance of flies, and the way for the latter is prepared by the action of dust in dry weather upon the upper respiratory tract. In the closing quarter of the year scarlet fever, diphtheria and the typhoid group usually reach their maximum. The rise of scarlet fever and diphtheria at this season may be ascribed to the aggregation of children in home and school after the opener life of summer, and that of the typhoid group regarded as a late consequence of fly prevalence.

Diseases such as tuberculosis, influenza, syphilis, mumps and chicken pox prevail in the westerlies as elsewhere, but malaria, plague, leprosy and cholera, still rife in other lands, have no hold in Britain, partly as a result of general social progress, partly owing to improved methods of water supply and disease control.

The Westerly Zone S. is a realm of sea, invaded by New Zealand, Tierra del Fuego and Tasmania. The westerly winds in the Roaring Forties are strong and steady. The weather conditions are more uniform than in the northern belt, but in general rather cheerless.

Horse Latitudes

The Horse Latitudes typically possess a tranquil sunny climate and many of the health resorts of the world are sited in these pleasant regions. The typical climate is not however continuous round the globe, and even in places justly famous for their good weather the normal calm may be disturbed by obnoxious local winds. The horse latitudes N. take in the Azores and Madeira, the Mediterranean seaboard and the United States between North Carolina and Monterey. The horse latitudes S. embrace part of Australia, the Cape Province and South America between the River Plate and Valparaiso. Horse latitude climates may undergo seasonal changes of position, of which the Riviera furnishes an example.

During winter and spring the French Riviera, which extends from Toulon to Mentone, is under the control of the westerlies and experiences a substantial rainfall. For the rest of the year, on account of the poleward extension of the trade winds in summer, it enjoys a horse latitude climate with almost unbroken fine weather. The relative humidity of the air is low, and its mildness is sustained by the adjacent Mediterranean which is here considerably warmer than the Atlantic in the same latitude. While the coast is protected to northerly by the Maritime Alps it is vexed in spring by the impetuous Mistral and in summer by the depressing Sirocco. The Riviera permits to sick people an open air life which they could not endure in a climate like that of Britain. It is good for convalescents and weakly persons, and for certain types of bronchial catarrh. Each resort claims its special aptitude, Hyères for early renal disease, Cannes for tuberculosis in children and Grasse for cases of neuralgia or rheumatism.

The Italian Riviera is the coast of Italy from Ventimiglia to Pisa. Its western portion in its climatic features is not unlike the French Riviera which it adjoins. San Remo is warm and mild and described as suitable for nervous patients and those suffering from bronchitis with dry cough. The eastern portion is as a whole moister and cooler than the western. Nervi gets too much of the Sirocco, but Rapallo is pleasantly mild and Spezia beneficial in cases of insomnia.

Madeira, though situated in the horse latitudes, has mainly an oceanic climate. Its warm moist air is relaxing to people in health, but may help to conserve the forces of invalid elderly persons and afford relief in cases of bronchitis with or without emphysema.

Trade Winds

The Trade Winds blow in the tropical belt and extend beyond its boundaries to the horse latitudes N. and S. Their position is subject to seasonal variation. Over the Atlantic they range from 35° N. to 25° S. with the zone of equatorial calms between. In the wide monsoon tract, which covers the Arabian Sea, the Bay of Bengal, the Malayan Archipelago, Northern Australia, the coast of China, the Sea of Japan and Sakhalin, the trades are seasonally reversed or reinforced by the monsoon winds.

Trade winds blowing on-shore from the sea are charged with moisture, and the air ascending over the land is soon cooled to the point of condensation. There is thus heavy rainfall on the easterly coasts of Madagascar, south east Africa, Central America and Brazil. The north east and south east trades, meeting together, water the forests of the Amazon and carry their rain to the eastern slopes of the Andes. Such places are typically hot and wet. Eastern Australia receives trade wind rains: North Australia, Borneo, India and the Gulf of Guinea have monsoon rains.

Unless on easterly coasts, the trade winds, blowing from high latitudes to low and decreasing in relative humidity as they grow warmer, are drying winds. Hence much of the desert land of the world lies in the trade wind belts. In the zone of the north east trades are the Sahara, the Libyan, Arabian and Persian deserts and the Thar in India. In the south east trades are the arid interior of the Australian continent, the Kalahari desert in South Africa, and in South America the long rainless strip, stretching from the Equator to 30° S., under the lee of the Andes. Such places are typically hot and dry.

Equatorial

The Equatorial zone of high temperature, calms and variable winds lies between the trades and shifts its position with them. The thermal equator follows the Equator proper over the oceans but throws out salients northerly over Mexico, the Sahara and India. The hottest circle of latitude is that of 10° N. In the equatorial region the vertical rays of the sun and the meeting of the north east and south east trades produce rapidly ascending air currents and consequent copious rainfall, which nurtures the forests of Brazil, Equatorial Africa and Borneo. Such places are hot and wet. The typical equatorial rainfall has two maxima and two minima but is subject to alteration by the monsoons and other causes.

The equatorial belt and the two trade wind zones as far as the tropics of Cancer and Capricorn are necessarily subject to tropical conditions and have therefore tropical climates.

The strong insolation of the tropics is better borne by the dark-skinned than by the white races, since the pigment in the dark skin converts the light rays into heat and stimulates perspiration. The tan colour produced in white-skinned people by residence in the tropics is a protective reaction of the same kind, as is also the so-called tropical pallor which is due to increased opacity of the epidermis and not to blood changes. The clothing worn in the tropics should be loose-fitting. The fabric known as 'solaro' has been recommended for its coolness. It is a textile made of yellow, blue and red threads so woven together as to give khaki colour on one side, for presentation to the sun, and red on the other. Head-gear should be of light weight and capable of reflecting the heat rays. It may be lined with red or orange silk. As regards the style, special sun-helmets with broad brims are regarded as essential for the hot and humid climates of India, Ceylon and West Africa. In Northern Australia, on the other hand, and in Java and British Guiana wide-awake hats, as commonly worn, seem to give adequate protection.

In tropical climates which are hot and wet the aqueous vapour in the atmosphere, receiving both visible solar rays and dark heat rays from the earth, distributes added heat down upon the place beneath. This is all the more discomforting to the body of man because the air at ground level is too wet to evaporate moisture freely from the skin and produce coolness. In addition the air itself is expanded by the prevailing high temperature so that the partial pressure of oxygen is reduced. The activity of the vital exchanges is habitually depressed, and energy declines to a low ebb. Nature in return is often bounteous so that a minimum of effort may suffice to provide a way of living. The native races of humid tropical lands are indolent and unprogressive.

As regards the reaction of European stocks to a hot and moist climate, one of the test cases quoted is that of a group of people of British blood in the new-formed United States, who after the close of the War of Independence elected, as Empire Loyalists, to remain under British rule. Some proceeded to Canada, where they made good. The rest migrated to the moist Bahamas on the edge of the tropical belt. There they appear to have lost initiative and sunk far down in the social scale. The Latin races of Europe by contrast have shown a capacity for tropical adaptation. There was certainly no shortage of enterprise in the original seizure of the Antilles and tracts of the two Americas by the *conquistadores*. So too in Northern Queensland during the last half-century or more a pure-bred white population has grown up under strongly tropical conditions, and is proving itself equal to every exercise necessary to the prosperous working of local industries.

The tropical hot and dry climate is typically that of the deserts, with their alternation of fiery days and cold nights. In the day-time the sand of the Sahara may reach 150° F.: during the night it may cool to below freezing point. These wide oscillations between heat and cold stimulate the bodily metabolism and promote vital energy. Vegetation being sparse or absent, the desert life is difficult and precarious, fostering valour and independence and tending to produce turbulent and war-like races. Such were the Touaregs lately. Twice in the world's history Persia became a conquering power. The Saracen empire was an out-standing achievement of the desert-born.

Europeans proceeding to a tropical climate should, as far as possible, time their arrival to take place well in advance of the local hot season. This arrangement permits of some acclimatisation before the advent of that most trying period, when the hot moist environment strains the temperature regulating mechanism of the body, deranges the digestive system and may induce a nervous condition attended by emotional unbalance. Such nerve disturbances, according to M. Culpin, are not specifically tropical but are of the same type as people may suffer from in any climate. It would therefore appear to be misleading to speak of 'tropical neurasthenia' as a disease unity. In the same way though anaemia occurs in the tropics in the course of certain infections there is no 'anaemia tropicalis' of purely climatic origin. But it seems probable that there is a lowering of basal metabolism in hot countries with which their climate has a good deal to do.

The one-time high mortality of Europeans in certain tropical lands—whence such reprobative epithets as 'the white man's grave'—has within comparatively recent years been signally diminished through the introduction of new methods for the control of disease. The climatic influence however remains, and life in the tropics still demands of European residents the exercise of precaution. A regimen should be observed and more attention given to questions of clothing, physical effort, diet, the use of alcohol and the maintenance of cool indoor conditions than would be necessary elsewhere. Simple tastes, a balanced mind and an annual change to a cooler station are all invaluable. Women and children under tropical conditions suffer more than men.

Heat Stroke develops in an environment which impedes the normal heat exchanges of the body and, if the experience continues, finally produces derangement of the mechanism of heat control. It is specially prone to occur in tropical climates which are both hot and wet, though it was observed in Iraq that a shade temperature of 120° F. for three days sufficed to produce cases of heat stroke despite low humidity of the air. The stroke may be ushered in by a prodromal phase of malaise, weakness and oliguria. The seizure proper is attended by vertigo and vomiting, followed by coma and convulsions. In untreated cases the rectal temperature may rise to 112° F. and death supervene in a few hours. Sequelae in cases which recover are headache, photophobia and mental dullness. The requisite in treatment is to control the pyrexia without producing collapse. Ice bags, cold sponging, covering with a wet sheet in a stream of air propelled by a fan have all been found of service, but the remedy *par excellence* is the artificially cooled hospital ward kept at a temperature round 60° F. For the prevention of heat stroke the clothing should be appropriate to the tropics. Regular exercise should be taken but exhaustion avoided. The diet should be adequate in carbohydrate, but not too rich in protein or fat, and salt should be added to it. The principal meal should be taken in the evening. Lemon drinks are commended. Beer is not advisable, unless very light. Over-indulgence in alcohol is dangerous and may provoke the seizure.

The infections peculiar to warm climates are either (1) strictly tropical in their distribution or (2) tropical and sub-tropical, including the whole of the trade wind zones.

The strictly tropical infections comprise the African sleeping sickness and the corresponding trypanosomiasis of South America. The range of the former is fixed by the fly belts of its vector Glossina, and that of the latter by the activities of a winged bug. Certain skin affections also belong to this limited group: for example, the 'prickly heat' of India and the *Tinea imbricata* of the farther Orient.

The tropical and sub-tropical infections are also in a number of instances controlled by the habitat of a vector insect. The prevalence of the Leishmania diseases and of sand-fly fever is conditioned by the presence of psychodid flies. Filariasis occurs only in the proximity of certain types of mosquito, midge or gad-fly. Dengue mainly follows the flight of *Aedes aegypti,* as also does yellow fever, unless in South America. Similar limitations govern the metazoan infestations. The Asiatic liver and lung flukes and the blood fluke Schistosoma depend for their transmission on the intermediary aid of local species of snail. In the same way dracontiasis needs the concurrence of a local crustacean. Ground temperatures not below sub-tropical registers are essential for the survival in the open of the embryos of the hook-worm in order that they may be able to seize the opportunity of invading the body of a new host. The spread of this infestation in England during the early years of the present century took place below ground only, in the deep tin mines of Cornwall which were sufficiently hot. Yaws, whether conveyed by contact or by the agency of flies, falls to be added to this group.

Sprue also is a disease of the tropics and sub-tropics. It is attended by catarrhal inflammation of the alimentary tract and has been ascribed to calcium deficiency. Good results are claimed for the administration of calcium lactate and parathyroid extract. The vitamin folic acid is cited as a remedial agent. Sprue is found in India, Java, and the far East as well as in Queensland, the West Indies and southern States of North America.

Of the infections which occur in the tropics but are not restricted to these regions some are cosmopolitan, at home in every climate and comporting themselves the world over in much the same kind of way. Examples are tuberculosis, syphilis, chicken pox, measles, whooping cough and mumps. There are others which, like typhoid fever, variola major, cholera, dysentery, malaria, plague and leprosy, are more prevalent and more severe in the tropics than in cooler climates like that of the westerlies. Differences in temperature and humidity may in some instances furnish a partial explanation for these tendencies, but in general there can be little doubt that the bad eminence of the tropics with respect to the diseases named results in large measure from the social and sanitary short-comings of native communities. In the matter of climatic preference scarlet fever is in a class by itself. Though common enough in Britain and other countries in the westerly zones it is almost unknown in tropical areas.

Europeans proceeding to a tropical climate should undergo inoculation against the communicable diseases prevalent in the area which admit of such prophylaxis.

II.

CONTINENTAL TYPES

In continents generally the summers are hot and the winters cold. The diurnal oscillations of temperature are great, often exceeding 40° F. The mean annual range in Canada may be 150° and in Siberia 170°. The amount of rainfall in continents grows less as the distance from the sea increases. In Western Europe in the zone of the westerlies the average rainfall is 30 inches, apart from heavier local rains which are due to the presence of mountains: in Eastern Europe the average is 20 inches: in West Siberia 15 inches and in East Siberia 10 inches. Interior tracts of large continents, especially if shut in by barrier mountains like the Desert of Gobi in Mongolia, may be practically rainless. The Continental types of climate are those of (1) plains, (2) plateaux, and (3) mountains.

Plains

Continental plains have wide ranges of temperature and low humidity. The summer rains are usually the most copious and the seasons well marked. Where the soil is fertile cereals are raised, as on the Canadian prairie, but the flat monotonous landscapes were devoid of interest and tended in early days to create in some a sense of isolation which in extreme cases led to mental derangement. Nowadays the telephone service and the wireless broadcast have established cheering links with the busy world.

Plateaux

Plateaux are uplands or high table-lands between the plains and the steeps of the mountains. Temperature and pressure decline and the rainfall increases as the level rises. The plateaux of India have a moderate mean temperature, and their hill stations provide a cool refuge to which British residents from the plains resort to escape the hot season. Such a change of scene is of special importance to women and children. Hill stations are utilised also in Ceylon and the Philippine Islands. The environments of the Kenya uplands and of parts of the Persian plateau conduce in a similar way to the well-being of Europeans. New arrivals, owing to the lowered partial pressure of oxygen, are apt at first to feel breathless on slight exertion but, unless the station is a very high one, acclimatisation is soon effected. Though the climate of the tropical plateaux has been fitly described as perpetual spring it lacks the stimulus to the vital forces supplied by the changing seasons of the westerlies.

Mountains

The air temperature on mountains decreases with elevation. It falls at the rate of 1° F. for every 300 feet of ascent. Hence the line of perpetual snow runs at 19,000 feet on the Himalayas, but at 7,500 to 9,000 feet on the Alps. Above 7,000 feet the mountain air is hygroscopic, causing the skin to crack and provoking thirst, but insolation and irradiation are intensified, the sun shining more strongly than at lower altitudes.

Atmospheric pressure also declines as height increases. On the peak of Kenya it is half the normal at sea level. In the rarefied air the low partial pressure of oxygen fails to meet the physiological requirements of the body, and the resulting anoxaemia manifests itself in cyanosis or, when the medulla becomes affected, sets up the symptoms of mountain sickness.

This notorious complication of high ascents is attended by lassitude, headache, nausea, vomiting, quick pulse and respiration, together with pallor, cold extremities and cyanosis of the lips and finger-nails. J. Barcroft and his co-workers, ascending the Peruvian Andes in a well-warmed railway carriage, noted blueness of their finger-nails at 8,000 feet. At Cerro de Pasco, their destination, 14,200 feet above sea level, they appear to have experienced a blurring of the mental processes. Expert physiologists of the party found the slide rule difficult and logarithms a burden, and required long intervals for recovery after using these aids to calculation. In like manner mental hebetude, followed by drowsiness or coma, lies in wait for the high-flying aviator if his oxygen supply gives out.

Acclimatisation of the human body to altitude is effected by an increase in the number of the red corpuscles of the blood. At first the rise is produced by the liberation of stored mature forms from the spleen pulp, later by fresh proliferation from the bone marrow. Hingston records that in natives of the Pamir the number of red corpuscles per cubic millimetre was 6,000,000 at 8,000 feet and 8,300,000 at 18,200 feet. Where the polycythaemia fails to make a sufficiency of haemoglobin available cyanosis becomes permanent until the person descends to a lower level. Barcroft observed that at Cerro de Pasco the indigenous Cholos, normally a brown race, were plum coloured. They had also clubbed fingers and barrel-shaped chests with the dorsal portions of the ribs abnormally horizontal. In major mountain climbing, as in the case of Kanchenjunga, a slow ascent has been found to help acclimatisation, but at 20,000 feet or thereby useful acclimatisation ceases.

Other disease conditions associated with mountains are the tabardillo of Mexico, a fatal form of typhus fever, and the kindred spotted fever of the Rocky Mountains. Oroya fever and Peruvian wart, both conveyed by a psychodid fly, occur on the Andes. Goitre, which may be accompanied by an incidence of cretinism, thyroid adenoma and exophthalmos, affects the people of mountainous regions such as the Himalayas and Rocky Mountains, or the Appalachian highlands, Andes, Alps and Pyrenees. It is found also on minor elevations such as the Cotswold Hills, the Mendips and the Peak District of Derby, whence 'Derbyshire Neck.'

It was once believed that the inhabitants of high situations enjoyed by reason of such altitude an immunity to tuberculosis. This view is no longer tenable, but the open air *régime* at mountain places of moderate elevation has proved of signal value for the treatment of the disease in some of its forms. Among stations of this class may be cited Arosa and Davos in the Grisons and Leysin in the Vaudois Alps, all at heights round 5,000 feet above sea level. Exposure to the warm sun and cool dry air of the Alps benefits early cases of phthisis in whom the disease is localised and the power of response good. Emaciated patients with exhausted vitality and cases of laryngeal tuberculosis are however unsuited for Alpine treatment. Cases of bronchial asthma may do well in the dustless atmosphere. The heliotherapy of surgical tuberculosis at Leysin is justly famous.

III.

MARINE TYPES

Marine climates owing to the presence of the sea are typically moist and equable. The annual variation of temperature at Valentia on the coast of Kerry is only 14° F. Owing to its greater specific heat the sea both warms and cools more slowly than the land. The aqueous vapour which it contributes to the atmosphere arrests part of the solar energy. Of the radiation which reaches the sea much is reflected back. Of the rest part disappears as the latent heat of vaporisation and part is diffused through the mass of the water by the turmoil of the waves. The clouds which the sea engenders keep air temperatures down by day by reflecting the sun's rays back into space, and check loss of heat at night by returning terrestial radiations to earth. The types of marine climate are (1) Oceanic, (2) East Coast and (3) West Coast.

Ocean

Ocean climates, which are those of the wide open sea and detached islands or island groups situated in the sea, have the general character of marine climates modified by the wind zones. The blustering of the westerlies, the comparative dryness of the horse latitudes, the fine weather of the trades and the calms of the equatorial belt all produce different types of ocean climate. Thus the Falkland Islands in the westerlies S. are cold and wind swept, whereas Madeira in the horse latitudes N. is warm and mild.

While the oceanic climate, as experienced on ship-board, necessarily alters with latitude, there is often in sea voyages little daily variation of temperature and the humidity of the atmosphere is usually not extreme. The sea air is pure, being free of land dust, and in and about self-propelled ships, unless with a following breeze, there is always some air moving. The free winds have a cooling power which stimulates metabolism. Sea voyages have been recommended for chronic laryngitis and catarrhal bronchitis and rhinitis, for convalescence after acute illness or surgical operation and for debility following influenza. Persons subject to certain strains of hay fever may escape an attack by sailing the sea during the season when the provocative pollen is adrift on land. A sea voyage may benefit some types of neurosis, but should not be casually resorted to in this or other forms of mental disturbance. In the era of sail, weather permitting, the overstrained city man embarking on a sea voyage could count on a sequence of restful days and nights free from business cares. Nowadays he is apt to be caught up in the giddy whirl of the cruising liner, or to be found conducting his business in the home town by wireless from mid-ocean. A certain discretion should be exercised in the choice of a ship. Persons in search of health from the sea should travel in steamers of moderate tonnage, which are proceeding on their usual run with few ports of call.

East Coast

East coasts in the westerlies are typically subject to off-shore winds and have dry climates. The east coast of Patagonia is conform to type, but the east coast of the United States in the westerlies has a pronounced rainfall of local origin, while Japan in the westerlies of the Pacific endures a monsoon climate. East coasts in the zone of the trade winds experience on-shore winds and have in consequence wet climates. It is so in Central America and Brazil, East Africa and Madagascar. The east coast of China is an exception, being under monsoon influence.

West Coast

West coasts fronting the westerlies, as in Britain and western Europe, British Columbia and southern Chili, have wet climates. In the trade wind zones, where the drying winds blow off-shore, west coasts are arid or desert. Such are Africa north of Senegal and again round Walfish Bay, Lower California and the coast of Peru, and parts of Western Australia. In Equatorial Africa the west coast is wet owing to monsoon rains.

The wetness appropriate to a west coast lying in the path of the westerlies is most apparent in the British Isles on the Atlantic shore. Valentia has a rainfall of 55 inches, as contracted with 27 for Dublin and 23 for Kew. In Scotland the western mountain masses cause the westerly winds to throw down their moisture, which tends to accentuate the difference between west and east. Thus in the west, round the Dunbartonshire Ben Vorlich, there are 120 inches of rain: at Aberdeen on the east coast only 29. It is brought out by Fig. 208 that the rainfall decreases in Great Britain from west to east, ranging as a rule on the westward coasts from 40 to 60 inches (1000 to 1500 millimetres) and on the east coast from 24 to 32 inches (600 to 800 millimetres).

Many resorts situated on the southerly and south westerly coasts of England are esteemed by reason of their mild and equable climates, for which they are largely indebted to the influence of the westerlies combined with winter sunshine and the warmth conveyed by the Gulf Stream. Individual differences however occur, some places being well sited to catch the sun or to enjoy shelter from the prevailing winds, while others are less favoured. Even within the limited area of the Isle of Wight,

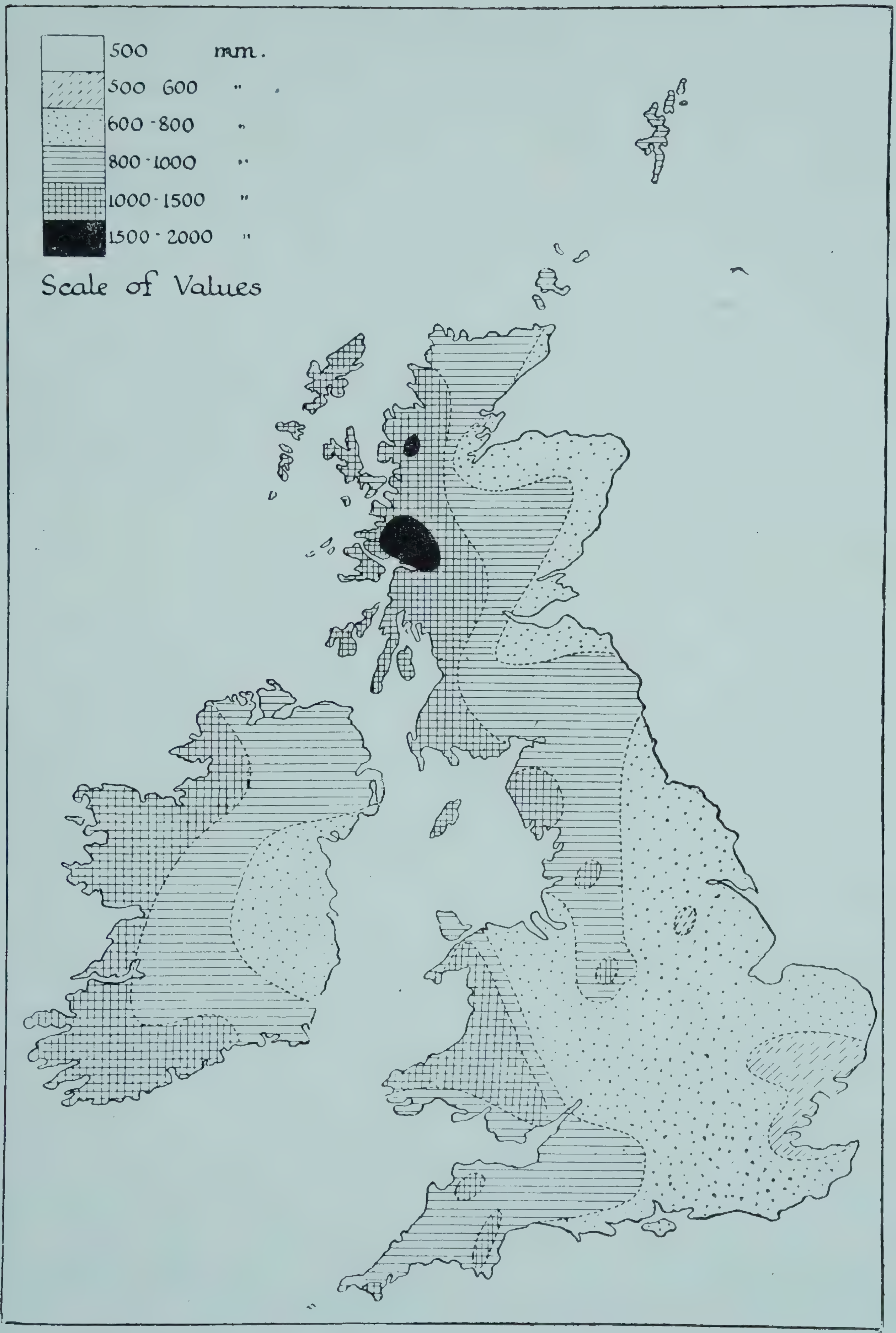
500 mm.
500 600 "
600 - 800 "
800 - 1000 "
1000 - 1500 "
1500 - 2000 "
Scale of Values

Fig. 208.—Mean Annual Rainfall: British Isles, 1876-1910.

as noted by M. B. Ray, variety of climatic character is recognised. Shanklin and Sandown serve to reinforce the vigorous, Cowes and Ryde will refresh the jaded, while Ventnor is tempered to the disabilities of the sick and feeble. Among the conditions which, it has been claimed, may be ameliorated by residence in a suitably mild coast resort are cardiac disease, nephritis, insomnia, various types of bronchitis, nervous affections and certain asthenic states. Benefit may be derived also by convalescents.

Persons seeking more bracing surroundings, with dryer air and fresher breezes, will find appropriate centres along the whole of the east coast of England and Scotland from Kent to Northumberland, and from Berwick County to Aberdeen. On the south shore of the Moray Firth weather conditions are dry and sunny even in winter. The coast resorts of the west of Scotland, of the north west English maritime counties and of Wales and Ireland generally are, as already indicated, more humid than in the east. Many of them are holiday centres, greatly frequented in the summer months, while some are reputed beneficial for respiratory and other disorders.

Sun- and sea-bathing or both combined, as practised at coast resorts, are if judiciously used conducive to health, and in the case of children have been found to be of therapeutic value.

In sun-bathing general insolation of the body surface is aimed at, but the area of skin exposed to the rays should be small at first and increase gradually. The process of insolation tends to be accompanied by a higher consumption of oxygen. If the body becomes heated by the sun this good effect is lost. The sun bath therefore should be taken in cool gently moving air, which is happily often available at the sea side.

In sea bathing the flowing tide is better than the ebb. The water is in livelier movement and carries a higher charge of salt. With a cold sea the shock of immersion constricts the peripheral circulation and schools the capillaries of the skin in the protective response to surface chilling. The concurrent deep inspirations inflate the lung, and by augmenting the oxygenation of the tissues reinforce the vital exchanges.

The combined influence of sun and air is well exhibited in the marine treatment of bone-joint and glandular tuberculosis in children at Hayling Island. The rainfall in this situation is low and the climate dry and sunny. It has been observed that the united impact of wind, sunlight and the breaking wave may make too heavy a demand upon the reserves of some children. The patients are therefore carefully selected and as carefully acclimatised, first to the breezes and the sun and then to the salt water. The results are well known to have been remarkable. Sir Henry Gauvain, the author of these achievements, has expressed the view that 'for English children the cold of the fresh English seas is more suitable than the warm but enervating Mediterranean.

XXV.

INTERNATIONAL HEALTH RELATIONS

International health relations are maintained in time of peace by means of a system of *International Hygiene* in accordance with which each country, with the co-operation of all, adopts measures for its own protection against invasion by disease liable to be conveyed to its territory from other lands. Many of these protective measures are most conveniently put into operation at *Sea Ports* or *Air Ports*.

INTERNATIONAL HYGIENE

The Office Internationale d'Hygiène Publique, founded in 1907, takes to do with the international control of infectious disease, drafting for that purpose international conventions for adoption by the various countries and publishing in peace time regular bulletins of information. The Convention of 1926 is now in operation in Britain under the Port Sanitary Regulations referred to below. Among matters which have engaged the attention of the Office are the Mecca pilgrimage, the conveyance of yellow fever by aircraft and the treatment of venereal disease in merchant seamen.

The Health Organisation of the League of Nations was established in 1923. It had offices and staff in Geneva, advised Governments on request regarding their health services, and compiled and circulated epidemiological information. It usefully promoted international measures for the control of the drug traffic, and for the protection of women and girls.

SEA PORTS

A seaport sanitary authority is principally concerned with infectious disease in man, plague among rats on ship-board and imported food. It has to do also with the sanitary state of ships in harbour and, through its medical officer, with the inspection of alien immigrants.

Infectious Disease. Under the Port Sanitary Regulations the master of a ship from a foreign port when approaching a port in Britain should send a wireless message ahead if the ship on arrival will require the attention of the port medical officer. Appropriate flags and lights also are prescribed to be shown. The master must fill in and sign a declaration of health, countersigned by the ship's surgeon, for delivery either to the customs officer or the port medical officer. An infected, suspected or unhealthy ship, in respect of plague, cholera, yellow fever, typhus fever or smallpox, may be required to moor at a mooring station specially appointed. No person except an official may board or disembark from the ship until she has been cleared by the port medical officer. The sick are removed to an infectious diseases hospital and suspects to an observation ward, and the names and destinations of all other persons disembarking are taken for communication to the medical officer of health of each locality affected. Disinfection is then carried out to the extent and in the manner appropriate to the particular disease, and the ship is finally granted pratique by the customs officer.

Rats on Ship-Board. Ships may be rat-proofed by screening openings in their bilges, using metal strips for pipe casings, installing metal flanges where pipe lines pass through bulkheads, and similar measures. In order to prevent shore rats from boarding ships in harbour and ship rats from escaping ashore, mooring hawsers should be fitted with unclimbable metal discs, needless gangways withdrawn or hoisted and the service gangway in use tarred or white-washed and, where permissible, illuminated.

To destroy rats on ship-board sulphur dioxide or hydrocyanic acid may be employed.

Sulphur Dioxide may be generated for ship use on the domestic plan. In the Clayton barge-mounted apparatus for large-scale work the gas, which is a mixture of SO_2 and SO_3, is produced by burning sulphur in a special furnace and propelling it by fans along tubes to the several parts of the ship. A concentration of 2 per cent. should be attained. Sulphur dioxide kills rats in empty holds: it is less effective in the presence of cargo and may damage the goods. It is however favoured by some on account of its safety to operators. Owing to its irritant character it does not fail to draw the attention even when present in amounts far below the danger level.

Hydrocyanic Acid is the most effective rat poison for ship use. The standard dose is 2 ounces per 10 registered tons, or 1000 cubic feet, allowing 2 hours' exposure for empty holds and 4 hours for ships with cargo. HCN is most potent in the liquid form, being sprayed out by means of an air jet at 200 lbs. pressure. For the protection of operators cyanogen chloride, CNCl, a lacrimatory warning gas, may be added to the spray.

'Cyanosorb,' which is liquid HCN, equivalent to 98 per cent. of the gas, absorbed in a dry granular medium, and combined with a lacrimator, has been developed by Imperial Chemical Industries to replace Zyklon, formerly employed in cyanide fumigation. The powder is spread on paper placed on the floors of the premises to be disinfested. Special care should be taken to protect tins containing 'Cyanosorb' against rust.

On the rather dangerous Nocht plan a mixture of the monoxide and dioxide of Carbon are employed.

In preparing for fumigation the ship should first of all, if necessary, be moved clear of other craft, or other craft lying alongside moved clear away. All ventilators and ports of the ship should be closed, and the ship put in a condition to be left with safety for 6 to 8 hours. The whole ship's company should be accounted for and the officer in charge should certify in writing to that effect. On completion, the ship is opened up by operators working in pairs and wearing full face special gas masks. An hour after the opening, a caged white rat is lowered to the bottom of each hold. If the rat is uninjured after 10 minutes' exposure the operators may go below. When they can enter all spaces with gas masks off, but at the ready, without discomfort from the tear gas, the ship is clear. The gas masks used may contain charcoal for short exposures: for longer exposures they may be charged with caustic pumice and iron hydroxide, as in the Siebe Gorman 'Puretha' mark IV. type. Filter paper soaked in a solution containing copper nitrate and benzidine acetate turns blue within 10 seconds in the presence of minute traces of hydrocyanic acid, but the animal test noted above is of greater practical use.

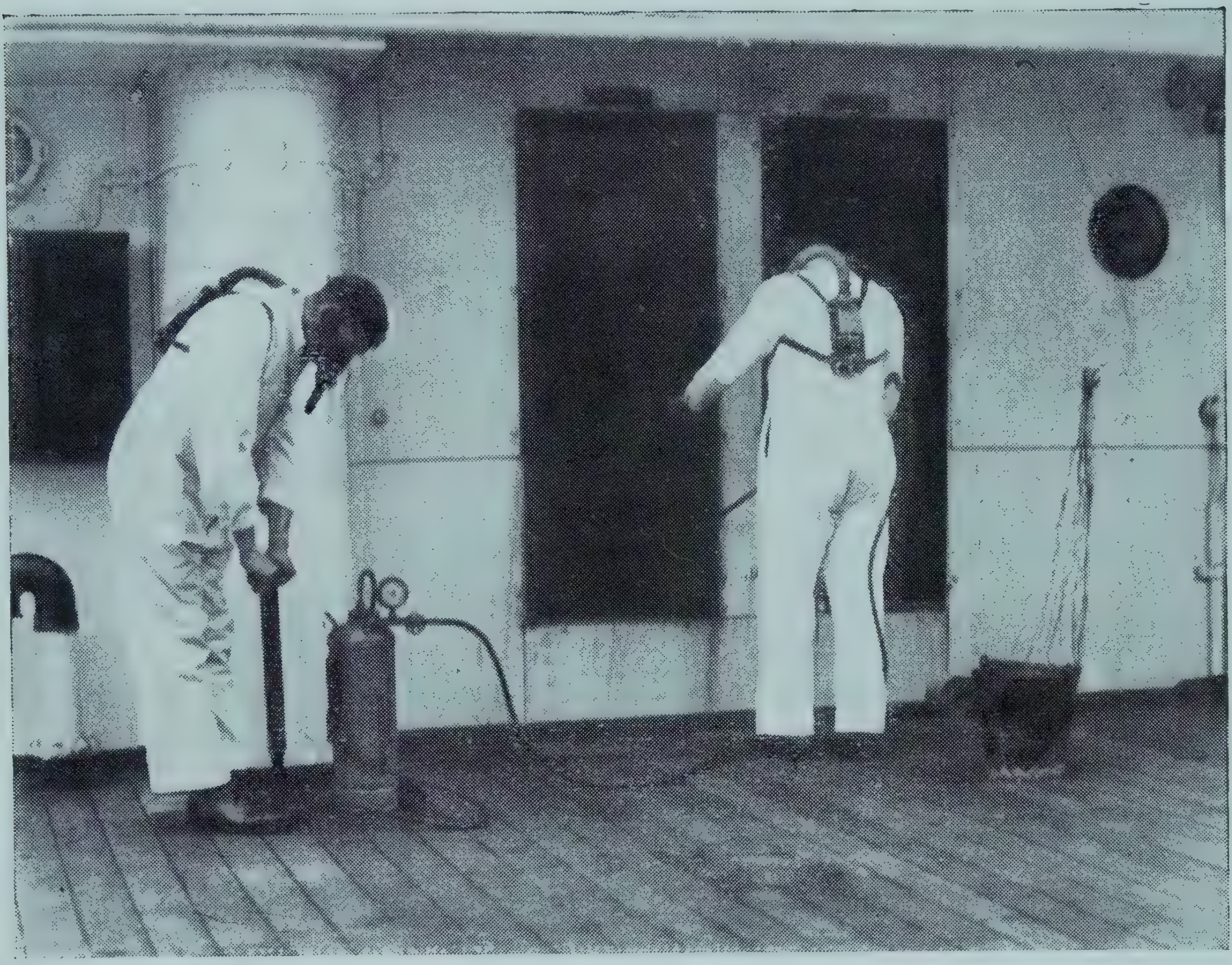

Fig. 209.—Ship fumigation by the spraying of liquid hydrocyanic acid gas. The operator on the left is pumping up an air pressure in the small cylinder containing liquid hydrocyanic acid gas. The operators are wearing gas masks without eye-pieces as no lacrimatory gas is mixed with the hydrocyanic acid gas in this method.

To dispose of rats in recesses $Ca(CN)_2$ dust, which bears the trade name 'Cyanogas,' may be blown into their harbourages with a foot-pump duster.

In terms of the Regulations all foreign-going ships must be inspected at 6-monthly intervals to determine the density of their rat population. If the rats are few, the port authority issues a Deratisation Exemption Certificate, which is good for 6 months. If the rats are many, steps must be taken, by the use of methods such as those above described, to reduce their number to the satisfaction of the port authority. Thereupon a Deratisation Certificate is given, also good for 6 months.

Imported Food may be examined by the medical officer of the port authority either on ship-board or after landing. If he finds it diseased or unsound he seizes it and conveys it to a Justice for condemnation in the manner already[1] set forth. With regard to meat the Imported Food Regulations forbid the importation of any scrap meat which cannot be identified as part of a carcase, or of pieces from which the pleura or, unless in the pig, the peritoneum has been detached, or of meat from which a lymphatic gland has been taken out. All other meat, including frozen or chilled meat, except entire carcases with the head naturally attached, must bear a label or stamp affixed by a competent oversea authority indicating that the meat was derived from animals duly inspected before and after slaughter and that all proper care was taken in preparing and packing.

Quarters. Passengers' accommodation in most ships nowadays is comfortable and often luxurious. For crews' quarters the space provided under the Merchant Shipping Acts must be not less than 120 cubic feet per white seaman and not less than 72 cubic feet per lascar. These structural details are supervised by the Board of Trade. Forecastles should be strongly constructed and free from leakage of water from ill-caulked decks. Condensation moisture may be minimised by cork-lining the forecastle walls. If unchecked it may soak bedding and cause hardships in other ways. A separate recreation cabin for seamen is advantageous. In ships bound east of Suez passengers' cabins should be fitted with electric fans. Decks should have double awnings, and there should be facilities for sleeping on deck. It is the business of the port sanitary authority to see to such matters as the proper ventilation, warming and lighting of quarters or, if there is infestation by bugs or cockroaches, to assist in the extermination of these pests.

Drinking water on board ship may be distilled water furnished by the ship's distilling plant but is more often soft natural water derived from shore sources and stored in special built-in steel tanks which are cement-washed internally. Special portable outfits for the de-salting of sea water are now available for ships' boats. The transport of the water is effected by water boats which come alongside. It is essential that all their pipe connections should be kept scrupulously clean. Recently one of us while investigating an outbreak of gastro-enteritis in one of H.M. ships isolated coliform bacteria in profusion from the ship's water tanks. On enquiry it transpired that the delivery pipe of the water boat had been allowed to trail in polluted estuarine waters during the run from shore to ship.

Latrines on board ship should be situated well forward and as far above the water line as possible. Wood fittings should wherever possible be replaced by Bakelite or other plastic. Soil pipes are equipped with non-return flap valves to guard against back surge of the sea.

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[1] Page 228.

Galley waste should be tipped into the sea by means of angled chutes designed to prevent fouling of the hull.

Aliens may land in the United Kingdom at approved ports only. On disembarking from their ship they come each in turn before the Immigration Officer, who ascertains their proposed length of stay, object of visit and money possessed. All pass in review before the Port Medical Officer, who stops and detains for subsequent examination suspicious cases or verminous-looking persons. Under the Aliens Order of 1920 leave to land in the United Kingdom may not be given to an alien who is a lunatic, idiot or mental defective, or is suffering from venereal disease in a communicable form, or from pulmonary tuberculosis, leprosy, favus, ringworm, impetigo, scabies or trachoma, or is found to be verminous. An alien suffering from acute infectious disease may have leave to land provided he remains in hospital till free of infection. A verminous alien may have leave to land after cleansing or disinfestation. An alien suffering from a disabling condition and likely to become a public charge may not have leave to land under any conditions.

A transmigrant is an alien booked through by way of Britain, say, from a continental country to the United States. If he is deemed unfit to be allowed to land in this country the shipping company are held responsible for his strict supervision and prompt return whence he came. If verminous he may have leave to proceed after cleansing or disinfestation at the expense of the shipping company.

Passenger Ships. The people brought by passenger ships represent all sorts and conditions. There may at this time be refugees among them, some of whom may be aliens, presenting problems of nationality. Those who joined a ship at a typhus-infected port will require to be inspected for vermin and, if found verminous, to be cleansed of their infestation. In the presence of smallpox every approved precaution can be intensified so long as the passengers are held on board the ship. When however, as is the present-day practice, possible contacts are permitted to land after stating their intended destination, their further surveillance may be lax, uncertain, or non-existent, with serious results. Indeed it is arguable that in appropriate cases the maritime quarantine abolished for Britain by the Public Health Act of 1896 may be better fitted than the current regulations to cope with seaborne smallpox. In November, 1943, a ship from North Africa presented herself at a City Port in the West of Scotland with a passenger on board suffering from confluent smallpox. General vaccination and revaccination were carried out, but the procedure permitting persons to land under conditions, as laid down by the regulations, was not resorted to. The ship was detained at her anchorage. The inmates of her sick bay were removed to hospital on land. Other passengers, including marine survivors, were transferred to various stations in the country where they were detained under observation until 14 days had elapsed since the case of smallpox was removed from the ship. The crew were not allowed to land but were kept on board under close observation until the ship put to sea. Happily no case of smallpox developed among crew or passengers, but if such an event had occurred it could not have escaped notice, and the patient would at once have been isolated in hospital and all proper action taken to prevent further spread.

Other facilities which those responsible may find it useful to develop or encourage at ports are hospitals staffed and equipped to receive the major infections, likewise observation wards and, for venereal disease, conveniently accessible clinics and in-patient accommodation. Other useful establishments are bathing centres, disinfecting points and delousing stations. With a view to the promotion of the welfare of the Merchant Navy, hostels or clubs should be provided for Officers, and lodgings or homes, duly separate, maintained for European and Asiatic seamen respectively. It is essential that such hostels or clubs should remain open until a late hour, in order that the men may escape the temptations of the streets.

It is important that deratisation should be diligently practised not only for ships but also for loading-sheds and other wharf-side buildings.

AIR PORTS

Oriental smallpox is in peace time the principal risk to this country from the airways. A person infected with smallpox in India, who travels by air, could be landed at an air port in Britain several days before the onset of his attack and so might be the means of starting an epidemic. Had he elected to come by sea he would have sickened on board ship, and been put ashore at Aden, Suez, Port Said, or perhaps Marseilles. In the event of his recovery from his attack he would have arrived in Britain long after he had ceased to be infective. Plague and cholera on the other hand have shorter incubation periods, and air travellers infected with them in India before taking off would fall ill at some stage of the flight, and be left behind for treatment at a convenient air-port hospital. Typhus fever, being associated with verminous persons, is not a likely air hazard anywhere.

With some exceptions long flights, such as that from India to England, were in pre-war days so arranged as to be carried out in a series of stages, between each of which the passengers changed into a fresh plane. In the case of the continental airways which converged on Croydon air port the final stage of the flight began at an air port in Paris, Brussels, or other centre, where the travellers changed and any infectious sick not already disposed of on the way would break their journey. This arrangement reduced the risk to this country.

In the case of yellow fever, which has an incubation period of 6 days, an air traveller infected in West Africa, the most likely source, could be landed at an air port in England with the onset of his attack still several days ahead. He would not however, when he became ill, be likely to communicate his malady since it is believed to be transmitted only by non-British culicine strains.

The risk however of the conveyance in planes of Aëdes mosquitos infected with yellow fever has, owing to the proximity of the West Indies, occasioned some concern in the Gulf States of North America which suffered severely from the disease during last century. Tests have shown that such conveyance could take place. Mosquitos released in the fuselage of planes taking off from Porto Rico on the 10-hour flight to Miami in Florida have been found still on board at Miami in substantial numbers. On regular routes such as this all vigilance can be exercised and planes readily cleared of mosquitos by fumigation with sulphur dioxide or by the application of a pyrethrum spray. It had been believed until lately that there was more serious risk in occasional flights from West to East Africa on the ground that yellow fever was endemic in the former and in the latter unknown, but the discovery that the mouse-protection test gives a high percentage of positives in parts to the south-east of Kordofan seems to suggest that East Africa is either already infected or is in more imminent danger from the north than from the west. At the 'anti-amaryl' aerodromes in endemic areas, where every precaution is taken for the exclusion of mosquitos from planes and their cargo, any person suspected of yellow fever is kept under observation before being permitted to embark.

Inoculation centres against yellow fever are now being set up by the Department of Health in Edinburgh, Glasgow, Aberdeen, and possibly Dundee and Inverness with a view to making protection certificates available for intending travellers to suspect areas overseas.

AIRCRAFT

Among the problems created by the development of civilian air transport are the ventilation, heating and sanitation of aircraft in flight. Under ideal conditions cabin air should be free from the odours of cooking or fuel, and its temperature should not exceed 65° F. It has been found that flying comfort is optimal when the feet of passengers are kept rather warmer than their heads, especially when the zephyr effect of air against the face can be maintained. Ventilation is generally accomplished by a modification of the balance system, air being admitted by means of laterally disposed cowls and exhausted by extraction fans placed at the rear of the craft.

Heating is supplied by pipes led through the cabin from the engine manifolds. It is to a large extent conserved by the thick insulation of kapok which is inserted between the inner and outer skins of the aircraft body.

Latrines may take the form of chemical privies or may consist of flushing bowls activated by water under pressure from a tank. The excreta are received into metal containers which are situated beneath the floor of the plane but are readily accessible for clearing on arrival at the air port. It is an offence under articles of the International Sanitary Convention to discharge from an aircraft in flight excreta or other material capable of causing outbreaks of infectious disease.

The Public Health (Aircraft) Regulations, 1938, provide for the control of persons conveyed by air to this country from areas where cholera, plague, smallpox, typhus or yellow fever are endemic or have been prevalent.

Public Health (Aircraft) Regulations (Scotland), 1946

These regulations, which came into operation on 1st July, 1946, are designed to prevent the introduction of infectious diseases into this country through the medium of airborne traffic. They prescribe as set forth hereunder.

4. It is the duty of a medical officer of a district comprising a customs aerodrome to prepare and keep a list of localities, both in the United Kingdom and elsewhere, which are infected or believed to be infected with plague (human or rodent), cholera or yellow fever, or in which typhus fever or smallpox is believed to be epidemic. He is required to supply copies of every such list to the customs officers employed in the aerodrome and to the person in charge of the aerodrome. In preparing such lists he is to take account of all information sent to him by the Ministry of Health or the Departments of the Secretary of State.

AIRCRAFT ARRIVING

5. The commander of an aircraft coming from a foreign place shall on or just before the arrival of the aircraft at the first customs aerodrome at which it lands, unless for fuelling only, complete an 'aircraft declaration of health,' stating licence number, date of departure, places of call, number of crew, passengers, and passengers disembarking, whether any case of illness other than air sickness during the voyage, whether the aircraft has been disinsectised or subjected to other sanitary measures, and whether there are on board any living animals, birds, insects, bacterial cultures or viruses. The commander must deliver this declaration on arrival to the medical officer and, if required by him, produce certificates concerning any sanitary measures mentioned in the declaration.

Every passenger on an aircraft coming from a foreign place shall on or just before arriving at the point of final disembarkation or at any stopping place on the way deliver to the medical officer a 'personal declaration of health' stating his name, nationality, home address, address to which proceeding, whether holding a certificate of inoculation or vaccination against cholera, yellow fever, typhus or smallpox, and recent movements or illnesses if any.

6. The person in charge of the aerodrome upon receipt of information that a person on board an approaching or arriving aircraft is under suspicion of having an infectious disease other than tuberculosis is required to inform the medical officer and customs officer.

7. If an infected aircraft or an aircraft coming from an infected locality arrives at an aerodrome the appropriate measures, if the disease in question is plague, cholera, typhus or smallpox, are as prescribed in the First Schedule to these regulations, which is printed in full below.

8. Where an aircraft arrives at any aerodrome from a foreign place and the customs officer is informed that during the voyage there was a death not the result of an accident, or a case of illness suspected to be infectious, or that the aircraft had come from a locality on the Reg. 4 list, or that deaths not attributable to poison had occurred among rats or mice aboard, he shall detain the aircraft and report the situation to

the person in charge of the aerodrome or to the medical officer. The medical officer may question any person so detained and if he receives pertinent information communicate with the local authority of the district to which the person is going. If the person goes somewhere else he must transmit his new address to the medical officer of the area in which he left the aircraft.

The medical officer may direct that an aircraft arriving from a foreign place shall be detained for medical examination. He may notify the customs officer, and must inform the person in charge of the aerodrome of any directions he gives.

9. The detention of an aircraft by a customs officer shall cease when the medical inspection is completed or when the medical officer gives notice to the customs officer calling it off or when it has not been begun within three hours.

10. The medical officer shall inspect or cause to be inspected on its arrival any aircraft which has come from or called at any foreign locality on the Reg. 4 list, and shall inspect also any other aircraft which has come from or called at a foreign locality and on which there has occurred during the voyage any case of illness which was and may have been plague, cholera, yellow fever, typhus fever or smallpox, or on which rodent plague has occurred or been suspected during the voyage.

The medical officer shall, as soon as possible and in any case within three hours after a customs officer has given a direction for the detention of an aircraft, inspect the aircraft or cause it to be inspected or give notice to the customs officer that he does not propose to inspect it, and if the aircraft is liable to further measures he shall give notice in writing to the commander directing its further detention.

AIRCRAFT DEPARTING

11. The medical officer may examine any person proposing to embark on an aircraft whom he suspects to be suffering from plague, cholera, yellow fever, typhus fever or smallpox or from any other disease named by the Secretary of State or corresponding officials in England or Northern Ireland, and if the person shows symptoms of any of these diseases may prohibit his embarkation. He may also prohibit the embarkation of any person who has been in close relation with persons showing such symptoms.

If severe smallpox (variola major) exists in any part of Great Britain the medical officer may prohibit any person coming from such part who has been in contact with any person suffering from the disease from embarking on any aircraft going beyond Great Britain, Ireland, the Channel Islands and the Isle of Man;

Provided that no person shall be so prohibited if he satisfies the medical officer that he is sufficiently protected by recent vaccination or by a previous attack of smallpox.

12. Where the Secretary of State has declared a district to be infected with plague, cholera, yellow fever or other menacing disease, or to be a district in which typhus fever or smallpox exists in epidemic form, the medical officer shall comply with any requirement of the

Secretary of State for preventing the spread of the disease, and in particular shall give effect to the following provisions:

The medical officer may, and within three hours after receiving a request from the commander so to do shall, medically examine any person who proposes to embark on or is on board an aircraft.

The medical officer or other authorised officer may, and on the request of the commander shall, inspect any clothing, bedding or other articles intended for use by the commander or crew or any person who proposes to embark or is on board an aircraft which have been exposed to infection, and he may demand the disinfection or destruction of such clothing, bedding or articles.

The medical officer or other officer may require any infected parts of an aircraft to be cleansed and disinfected.

No body linen, clothing, bedding or other article capable of carrying infection may be taken on board an aircraft until the medical officer is satisfied that it has been efficiently disinfected.

If the locality is declared to be infected with plague the medical officer may, and if required by the Secretary of State shall, take steps to ensure the deratisation of any aircraft which harbours rats.

If typhus fever is declared to exist in epidemic form in the locality the medical officer may require any person who proposes to embark on or is on board an aircraft and who is likely to convey infection, and any article proposed to be carried likely to convey infection, to be deloused.

21 (2). This subsection is concerned with forced landings. If an infected aircraft or an aircraft coming from a locality infected with plague, cholera, yellow fever or malaria or a locality where typhus fever or smallpox is epidemic lands elsewhere than at a customs aerodrome, the commander shall forthwith notify the responsible authority or the customs officer or a police officer. He shall comply with any reasonable directions which any such authority or officer may give, and shall if possible proceed to a sanitary aerodrome. No cargo shall be unloaded from the aircraft without the permission of the customs officer.

Before any passenger or member of the crew leaves the vicinity of the aircraft the responsible authority or the customs officer or a police officer may require him to state his name and intended destination and address. If the person cannot state his intended destination and address or arrives within fourteen days at some place other than he said he shall on his arrival there forward particulars of his actual place of arrival together with his address to the responsible authority of the place where he left the aircraft. The commander shall take all steps in his power to secure compliance with the provisions of this paragraph.

'responsible authority' means the local authority for the district or, if the local authority maintains the aerodrome, the maintaining authority.

'customs aerodrome' means an aerodrome approved by the Minister of Civil Aviation as a customs aerodrome.

'sanitary aerodrome' means a customs aerodrome having an organised medical service, a medical officer or officers, a place for medical inspection, a laboratory for the examination of suspected material failing which equipment for transmitting such material to a laboratory, facilities for care of the sick, isolation and prophylaxis, apparatus for disinfection, disinsecting and deratisation, a sufficient supply of wholesome drinking water, a proper and safe system for the disposal of excreta and refuse and for the removal of waste water.

'medical officer' means the medical officer of health of a responsible authority or a registered medical practitioner acting under the direction of such an authority.

First Schedule

Measures to be carried out in respect of an infected aircraft or an aircraft coming from an infected locality.

PART A—PLAGUE

I.—*Infected aircraft*

1. The aircraft shall be inspected and the passengers and crew shall be medically examined.

2. The sick shall immediately be disembarked and isolated.

3. All other persons shall be placed under surveillance or, in exceptional circumstances, isolated, for a period expiring not later than six days after the date of arrival of the aircraft at the aerodrome.

The following further measures shall be carried out at a sanitary aerodrome:—

4. Bedding which has been used, soiled linen, wearing apparel and other articles which, in the opinion of the medical officer, are infected, shall be cleansed of vermin and, if necessary, disinfected, and merchandise proposed to be discharged may, if it is considered liable to harbour rats or fleas, be subjected to such measures as the medical officer thinks fit.

5. The parts of the aircraft which have been occupied by persons suffering from plague or which the medical officer considers to be infected shall be cleansed of vermin, and, if necessary, disinfected.

6. The medical officer may in exceptional cases require the aircraft to be deratised if there is reason to suspect the presence of rats on board and if the operation was not carried out at the aerodrome of departure.

II.—*Aircraft coming from an infected locality*

1. The passengers and crew may be medically examined.

2. Any such persons may be placed under surveillance or, in exceptional circumstances, isolated for a period expiring not later than six days after the date on which the aircraft left the infected locality.

The following further measures may be carried out at a sanitary aerodrome:—

3. The medical officer may in exceptional circumstances require the

aircraft to be cleansed of vermin and to be deratised if these operations were not carried out at the aerodrome of departure.

4. Merchandise proposed to be discharged from the aircraft, if the medical officer considers it liable to harbour rats or fleas, be subjected to such measures as he thinks fit.

PART B—CHOLERA

I.—*Infected aircraft*

1. The aircraft shall be inspected and the passengers and crew shall be medically examined.

2. The sick shall immediately be disembarked and isolated.

3. All other persons shall be placed under surveillance or, in exceptional circumstances, isolated for a period expiring not later than five days after the date of arrival of the aircraft:

Provided that any person who satisfies the medical officer that he has been vaccinated for cholera within the preceding six months, excluding the last six days thereof, shall not be isolated.

4. The medical officer may direct the disposal of foodstuffs on the aircraft.

The following further measures shall be carried out at a sanitary aerodrome:—

5. Bedding which has been used, soiled linen, wearing apparel and other articles which, in the opinion of the medical officer, are infected shall be disinfected.

6. The parts of the aircraft which have been occupied by persons infected with cholera or which the medical officer considers to be infected shall be disinfected.

7. If the drinking water stored on board is suspected by the medical officer, it shall be disinfected and if practicable emptied out and replaced, after disinfection of the container, by a supply of wholesome drinking water.

II.—*Aircraft coming from an infected locality*

1. The passengers and crew may be medically examined.

2. Any such person may be placed under surveillance or, in exceptional circumstances, isolated for a period expiring not later than five days after the date on which the aircraft left the infected locality:

Provided that any person who satisfies the medical officer that he has been vaccinated for cholera within the preceding six months, excluding the last six days thereof, shall not be isolated.

3. The medical officer may direct the disposal of foodstuffs on the aircraft.

PART C—TYPHUS FEVER

I.—*Infected Aircraft*

1. The aircraft shall be inspected and the passengers and crew shall be medically examined.

2. The sick shall immediately be disembarked, isolated and deloused.

3. Any other person reasonably suspected by the medical officer to have been exposed to infection shall, unless in the opinion of the medical officer the person is sufficiently protected by recent inoculation or by a previous attack of typhus, either

(*a*) be offered inoculation and placed under surveillance for a period not exceeding twelve days after the date of arrival of the aircraft, or

(*b*) be placed under surveillance for the said period without inoculation, or

(*c*) be isolated for a period of twelve days after the date of arrival of the aircraft:

Provided that the medical officer shall not impose a requirement set out in sub-paragraph (*c*) of this paragraph unless in his opinion there is an exceptionally serious risk of introduction of typhus into the country.

The following further measures shall be carried out at a sanitary aerodrome:—

4. Any person reasonably suspected to be harbouring lice shall be deloused.

5. Bedding which has been used, linen, wearing apparel and any other article which the medical officer considers to be infested shall be disinfested.

6. The parts of the aircraft which have been occupied by persons suffering from typhus fever or which the medical officer considers to be infested shall be disinfested.

II.—*Aircraft coming from an infected locality*

The passengers and crew may be placed under surveillance or, in exceptional circumstances, isolated for a period expiring not later than twelve days after the date on which they left a locality where typhus fever is epidemic.

PART D—SMALLPOX

I.—*Infected aircraft*

1. The aircraft shall be inspected and the passengers and crew shall be medically examined.

2. The sick shall immediately be disembarked and isolated.

3. Any other person reasonably suspected by the medical officer to have been exposed to infection on board shall, unless in the opinion of the medical officer the person is sufficiently protected by recent vaccination or by a previous attack of smallpox, either—

(*a*) be offered vaccination and placed under surveillance for a period not exceeding fourteen days after the date of arrival of the aircraft, or

(*b*) be placed under surveillance for the said period without vaccination, or

(*c*) be offered vaccination and isolated until the result of the vaccination is known and thereafter kept under surveillance until the fourteenth day after the date of arrival of the aircraft, or

(*d*) be isolated for a period of fourteen days after the date of arrival of the aircraft:

Provided that the medical officer shall not impose a requirement set out in sub-paragraph (*c*) or sub-paragraph (*d*) of this paragraph unless in his opinion there is an exceptionally serious risk of introduction of smallpox into the country.

The following further measures shall be carried out at a sanitary aerodrome:—

4. Bedding which has been used, soiled linen, wearing apparel and any other article which the medical officer considers to have been recently infected shall be disinfected.

5. The parts of the aircraft which have been occupied by persons suffering from smallpox or which the medical officer considers to be infected shall be disinfected.

II.—*Aircraft coming from an infected locality*

The passengers and crew, except any persons who satisfy the medical officer that they are sufficiently protected by recent vaccination or by a previous attack of smallpox, may be placed under surveillance or, in exceptional circumstances, isolated for a period expiring not later than fourteen days after the date on which they left a locality where smallpox is epidemic.

XXVI.

THE SOCIAL VISTA

SOCIAL MEDICINE

WE are permitted by Professor John Ryle to cite from his First Annual Report on the Oxford Institute of Social Medicine the following passage :

> ' Social Medicine is a comprehensive term. It may, in fact, be held to include the whole of the public and industrial health services, the social services and the remedial services of a community. But just as clinical medicine may be considered not only in terms of medical practice, but also as an academic discipline, so too may social medicine be considered. Its observations and researches are in connection with groups or ' populations ' rather than with individuals. It requires different methods and collaborations. Human pathology is the related science of clinical medicine. Social pathology is the related science of social medicine. A proper primary aim of an Institute of Social Medicine, working in close proximity to university departments and in conjunction with a medical school, should be to establish a status for its own science of social pathology : to develop such methods and techniques as may be necessary for the advancement of our knowledge of man in health and disease and, in particular, for the investigation of the social causes of disease : and to further the applications of such knowledge. For the fulfilment of these aims, a close association of clinical, social, statistical and other workers is necessary. The problems of social pathology must be sought in the field, and here the collaboration of those responsible for various types of ' population,' whether determined by age, sex, occupation, geography or otherwise, becomes necessary. The student of social pathology has this advantage over the student of human pathology in its more restricted sense—that, in his studies of groups, health as well as sickness, and the borderland between them, must frequently come under simultaneous review. The aetiology and manifestations of health are considered, as they should be, in conjunction with the aetiology and manifestations of disease.'

The practitioner who aspires to serve under the *labarum* of social medicine, so convincingly set forth above by Professor Ryle, will, while continuing to function as a skilled clinician, find his professional outlook widened by new horizons. Social medicine has many links with clinical medicine, and the interplay of clinical work, statistical studies and organised public health has an integrating value, which should foster a mutual interest among the exponents of each of these fields of medical activity.

How these exponents will ultimately stand to one another is on the knees of the gods, but it seems likely that, as social medicine extends the range of its usefulness, its major exponents will emerge as the practising doctor, the survey specialist and the medical officer of health.

The most important, because the most clinical, will be the practising doctor. He will require to undergo a course of training equal to his calling. This training he should receive as a medical undergraduate at his university or medical school.

Sir William Goodenough's Committee, in their report of 1944, point the way to the type of medical curriculum which will best meet the requirement of the occasion. The Committee say:

'A new orientation of medical instruction is proposed. The idea of social medicine should permeate the whole course of study. The foundation should be laid in the pre-clinical period, during the teaching of anatomy and physiology, since anatomy can help the understanding of growth and posture, while physiology, in connection with nutrition and fatigue, is rich in pertinent instances. From this stage onwards useful aid may be derived also from students' health services, the effects of exercise and training being observed and tests of fitness performed.

'During the clinical period of his curriculum the student should see his teachers enlisting the help of almoners, psychiatric social workers, health visitors and other welfare experts, and also considering clinical problems in the light of the patient's domestic circumstances and environment. He should also learn something of the communal and administrative aspects of preventive medicine, and should acquire an elementary knowledge of the duties and responsibilities of a medical officer of health. By this means he can be led to appreciate that prevention is a communal as well as an individual problem, and to realise the ways in which a general practitioner can help the medical officer of health and other public health authority, and in turn can be helped by them in his own practice.

'His understanding of these matters, and of social medicine generally, is likely to be aided if he is given an elementary account of the development of the medical and social services, of their relation to the social structure, and of how progress in the promotion of health has been hindered by such evils as bad housing, ignorance and unemployment. The historical approach can be a source of inspiration to the student.'

The General Medical Council, in November, 1945, adopted the following Rules as to courses of study and examinations for diplomas and degrees in Sanitary Science, Public Health, or State Medicine, which came into operation on 1st January, 1946.

RULES AS TO COURSES

1. The curriculum for a Diploma or Degree in Public Health shall extend over one or other of the following periods, namely, either

(1) An academic year of whole-time study: or

(2) Not less than eighteen calendar months of part-time study which shall in the opinion of the Licensing Body or Bodies which grants or

grant the Diploma or Degree be substantially equivalent to the period of whole-time study prescribed by this Rule: or

(3) Either (*a*) whole-time study during a Preliminary Course such as is prescribed by these Rules, and part-time study during a Final Course such as is prescribed by these Rules, or (*b*) part-time study during a Preliminary Course such as is prescribed by these Rules, and whole-time study during a Final Course such as is prescribed by these Rules, which shall in either case cover a period of not less than fifteen months, and shall in the opinion of the Licensing Body or Bodies which grants or grant the Diploma or Degree be substantially equivalent to the period of whole-time study prescribed by this Rule.

Provided that no candidate shall be admitted otherwise than as a whole-time student to any Final Course such as is prescribed by these Rules for any Diploma or Degree unless any part-time employment in which he proposes to engage during the period covered by the Course is approved by the authorities of the teaching body by which the Course is provided.

PRELIMINARY COURSES

Length of Courses

2. Every candidate shall produce evidence of satisfactory and regular attendance on a Preliminary Course covering an academic term of not less than ten weeks of whole-time study of the subjects of the Course, or an equivalent period, being a period of not less than 300 hours, of part-time study of the said subjects, provided by a teaching body approved by the Licensing Body or Bodies which grants or grant the Diploma or Degree, during which he shall have received instruction in the subjects prescribed by Rules 3 and 4 of these Rules.

Systematic Instruction

3. (*a*) The history of Public Health and Public Assistance: the evolution of central and local authorities in relation thereto: the evolution of the law in relation to Health, Public Assistance, and Social Security.

(*b*) The existing functions of central and local authorities and voluntary organizations, and the nature and objects of the Public Health and Medical Services they administer.

(*c*) Social Security, and the agencies for the relief of poverty and the promotion of social welfare.

(*d*) International health organizations.

(*e*) The nature and sources of information bearing on the health of the people, and its numerical presentation. The preparation of memoranda and scientific articles containing statistical data.

(*f*) The causal agents of infection, their sources and control.

(*g*) The influence on physical and mental health of environment, including house and occupation, economic circumstances and nutrition and personal hygiene.

(*h*) Physical education.

(*i*) The influence of heredity on health.

(*j*) The principles of Health Education.

Practical Instruction

4. (*a*) Practical demonstrations of problems illustrative of the subjects dealt with in the part of the Course devoted to Systematic Instruction.

(*b*) Exercises in the solution of epidemiological problems, and in the preparation of memoranda containing statistical data.

(*c*) Visits to places and institutions of importance to Public Health.

Preliminary Examinations

5. No candidate shall be admitted to a Preliminary Examination until he has completed the prescribed courses of instruction in the subjects of a Preliminary Course to the satisfaction of the Licensing Body or Bodies which approves or approve the teaching body by which the Course is provided.

6. Preliminary Examinations shall be conducted by or on behalf of the Licensing Bodies which approve teaching bodies for the provision of Preliminary Courses, and the Licensing Bodies shall appoint for the purpose Examiners specially qualified.

> Unless the Course has been provided by an approved teaching body which is a School of a University, the Examiners so appointed shall include an External Examiner or External Examiners

7. A Certificate in Public Health shall be granted by the Licensing Body or Bodies concerned to candidates who have satisfactorily completed a Preliminary Course and have passed a Preliminary Examination.

FINAL COURSES

Admission to Final Courses

8. No candidate shall be admitted to a Final Course with a view to admission to a Final Examination unless he presents to the Licensing Body or Bodies which grants or grant the Diploma or Degree a Certificate in Public Health within the meaning of Rule 7 of these Rules.

Any exemption from this requirement shall only be granted by the General Medical Council for special reasons on the application of the Licensing Body or Bodies concerned.

Length of Courses

9. Every candidate shall produce evidence of satisfactory and regular attendance on a Final Course covering a period of not less than five calendar months of whole-time study of the subjects of the Course, or an equivalent period, being a period of not less than 550 hours, of part-time study of the said subjects, provided by a teaching body approved by the Licensing Body or Bodies which grants or grant the Diploma or Degree, during which he shall have received instruction in the subjects prescribed by Rules 10, 11, and 12 of these Rules.

Systematic Instruction

10. (*a*) Physiology, Biochemistry, Food, and Nutrition, in relation to the Public Health.

(*b*) Bacteriology, Parasitology, and Medical Entomology, as applied to Epidemiology.

(*c*) Mass Aspects of Disease. Administrative measures in relation to communicable and other diseases.

(*d*) Sanitation, Water Supplies, Housing, Town and Country Planning, and the application of scientific principles thereto.

(*e*) Statistical Data and Methods.

(*f*) Interpretation of Plans.

(*g*) Administration. Organization and management of Medical Departments and Institutions.

(*h*) The law relating to Public Health.

(*i*) Mental Health Services.

(*j*) Occupational Health.

(*k*) Methods of educating the public as to the promotion and maintenance of health.

Clinical Instruction

11. Every candidate shall produce evidence that he has either (*a*) resided and received instruction for four weeks in a Hospital for Infectious Diseases

approved by the Licensing Body or Bodies which grants or grant the Diploma or Degree, or (*b*) attended satisfactorily and regularly and received instruction at such an approved Hospital for three months: and that in either case such instruction was received during the late autumn, winter, or spring:

Provided that a candidate who shows to the satisfaction of the said Body or Bodies that he has served for not less than six months as a Resident Medical Officer in such an approved Hospital may be exempted by the said Body or Bodies from receiving the clinical instruction prescribed by this Rule.

Practical Instruction

12. (*a*) Every candidate shall produce evidence that he has during a period of not less than five months attended at the Health Department of the Local Authority of an area approved by the Licensing Body or Bodies which grants or grant the Diploma or Degree, and has personally observed and studied the daily work of each section of the Department under the guidance of administrative, technical, and executive officers of the Authority:

Provided that a candidate who shows to the satisfaction of the said Body or Bodies either

(i) That he has held a whole-time appointment for not less than twelve months in the Health Department of the Local Authority of an area approved by the said Body or Bodies: or

(ii) That he is holding a part-time appointment in such a Department throughout any period during which he is receiving systematic instruction under Rule 10 of these Rules, and is regularly receiving guidance from appropriate officers of the Authority: and

(iii) That his duties under the terms of his appointment were or are such as to enable him to acquire a knowledge of Public Health administration at least equivalent to that which he would acquire by means of the practical instruction prescribed by this Rule,

may be exempted by the said Body or Bodies from receiving such instruction.

(*b*) No candidate shall be admitted to a Final Examination unless he has presented

(i) A Day-Book in which he has made regular entries relating to subjects in which practical instruction is given during the Course, and brief observations on the objects of such instruction, and the conclusions to be drawn therefrom.

(ii) A Dissertation on a Subject which has been approved by the authorities of the teaching body by which the Course is provided.

Final Examinations

13. No candidate shall be admitted to a Final Examination until he has completed the prescribed courses of instruction in the subjects of a Final Course to the satisfaction of the Licensing Body or Bodies which approves or approve the teaching body by which the Course is provided.

14. Final Examinations shall be conducted by or on behalf of the Licensing Bodies which approve teaching bodies for the provision of Final Courses, and the Licensing Bodies shall appoint for the purpose Examiners specially qualified, including an External Examiner or External Examiners.

15. Final Examinations shall include written examinations, a clinical examination in Infectious Diseases, an oral examination in Infectious Diseases, Epidemiology, and General and Special Hospital Administration, and a general oral examination.

16. Day-Books presented by candidates under Rule 12 (*b*) (i) of these Rules shall be made available to Examiners at Final Examinations, and the regulations for the several Final Examinations shall provide that Examiners shall, in assessing marks, take Day-Books into account as duly attested records of work done by candidates during Final Courses.

17. Dissertations on approved subjects presented by candidates under Rule 12 (*b*) (ii) of these rules shall be read by Examiners at Final Examinations, and the regulations for the several Final Examinations shall provide

that Examiners shall, in assessing marks, take into account the merit of Dissertations.

18. A Candidate must pass the whole of the Final Examination at one time.

POOR LAW OF ENGLAND

'The historical approach can be a source of inspiration to the student.' So it is said in the Report[1] by Sir William Goodenough's Committee on the teaching of Social Medicine. Fortified by this opinion we have ventured to piece together, albeit with prentice hand, the following historical note on the Poor Law of England.

The narrative opens in the eventful reign of Edward III, at a time when the legislature had perforce begun to take notice of the poor. There were then two classes of these persons (1) the able-bodied poor, known as 'valiant beggars,' and (2) the disabled poor, known as 'impotent beggars.'

The character of the 'valiant beggars' is revealed in the Statute of Labourers dated 1349. They are blamed in this Act for refusing to work and abandoning themselves to idleness, vice and other abominations. They were recognised to be dangerous vagabonds and were treated accordingly. From time to time their numbers would be swelled by some shift of the population such as ensued on the Black Death, the liberation of the vassals and, later, the suppression of the religious houses. The severity of the statutes launched against the valiant beggars bears witness to the persistence and gravity of their misdeeds. The 'impotent beggars' are mentioned in an Act of Richard II. As they were not formidable, the only injunctions laid upon them were that they should stay where they were when the Act was proclaimed, and that they should not wander about.

The Act of 1530 in the reign of Henry VIII issues its appropriate justice to both classes of the poor: the impotent poor may beg, if authorised by letter, but if they beg outwith their area, or in their area without a letter, they go to the stocks: able-bodied persons, if found begging, may on conviction be whipped through the town till blood runs.

Under Edward VI the Act of 1551 commits valiant beggars and idle and loitering persons to the rigours of the above-mentioned Act of Henry VIII. For the aid of the impotent, feeble and lame, 'who are poor in very deed,' the Act ordains a scheme in terms of which alms may be collected by 'gentle asking' and distributed to the poor at church meetings. Queen Elizabeth, in her Act of 1562, rounds off the scheme by fixing the action which should be taken if 'gentle asking' fails. It is that every householder in the parish, after being exhorted by the bishop and others, should pay what he feels he can afford to help the poor. If he refuses and remains obdurate he may, after sundry procedure, find himself in gaol. This scheme embodies the earliest approach to compulsory assessment for the relief of the poor.

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[1] Page 656.

Later in the reign of Elizabeth the vagabonds had been exceptionally destructive, and legislators had retaliated with severities such as grievous whippings and burning through the cartilage of an ear. At the same time they expressed their wish that the poor who are impotent to serve should get places to settle in, that the justices should ascertain the cost of this provision, and that the inhabitants of the division should be taxed for the money. An Act of 1597 repeals all previous statutes for the punishment of rogues, vagabonds and sturdy beggars, and puts forward instead a new list of occupations which qualify for these titles. All such, if caught begging, wandering or misordering themselves are liable, both men and women, to be stripped naked down to the waist and whipped till blood runs.

The poor law in the above setting combines compassion with severity, compassion being for the impotent but severity for the vagabond, yet there were those at this time to whom it seemed that the conditions of both groups was due to one and the same cause, namely destitution, which, as a public evil, might properly be eradicated at public charges.

This view found expression in the Act known as 43rd Elizabeth cap. 2 (1601), famous as having finally established the principle of a compulsory assessment for the relief of the poor. It empowers the overseers, with the consent of the justices, to raise in every parish from every inhabitant such competent sums of money as they think fit for the necessary relief of the lame, impotent, old, blind and such others among them being poor and not able to work.

Under James I, an Act of 1603 enjoins the charitable relief and ordering of persons infected with the plague. The sick are required to stay indoors. A person who comes out and converses in company, having upon him any unhealed infectious sore, is to be deemed a felon and suffer death. Another Act of the same year causes an incorrigible and dangerous rogue to be branded on the shoulder with the letter R. A bastardy Act, in the case of a woman having a bastard child chargeable to the parish, subjects her to one year's imprisonment with hard labour, and for a second offence to the like imprisonment until she puts in good securities not to offend again.

Under Charles II in 1662 came the Settlement Act. It enacts in substance that, if any person comes to a parish to settle in a tenement under the yearly value of £10, it shall be lawful for two justices to cause him to be removed and conveyed back to the parish where he was last legally settled. The aim of the Act was to reduce the numbers living in and about London, lest the city should prove overpopulous if the plague came back. This last apprehension was not ill-founded. The Great Plague of London broke out three years later. Elsewhere in the country the Act was pernicious. It immobilised labour, quenching hope and baffling enterprise. In later years it was the spring of much pointless litigation.

Under William and Mary the Act of 1689 abolished hearth-money 'as being a great oppression to the poorer sort.' William III expressed concern at the growing poor rate. Under Queen Anne the Act of 1707 provided a workhouse at Plymouth with a schoolmaster to teach the children. Her Act of 1713 sends rogues and vagabonds to their places of birth or settlement. Whether men or women they are to be stripped to the middle and whipped till blood runs.

During the reign of George I the Act of 1717 provides that felonious persons liable to be whipped may be transported to His Majesty's Colonies in America for 7 years, and that young persons lurking idle in London or elsewhere may contract with a merchant to serve him in the Colonies up to 8 years.

The Act of 1722 lays down that an applicant for relief who refuses to enter a 'parish house' shall no longer be entitled to relief of any kind.

During the reign of George II the Act of 1744 classifies wicked men. They are either disorderly, or rogues and vagabonds, or incorrigible rogues. They are liable to be whipped or sent to a house of correction. If they break prison they may be transported for 7 years. Their children will be apprenticed or put to service. When the wandering woman's child is born, the overseers are to hold her till quarter sessions. She may then be publicly whipped and sent to a house of correction for 6 months.

With the reign of George III we begin to sense a more genial air. Sir Jonas Hanway's Act of 1767 was the means of conveying to the country a group of pauper children under 6 years of age belonging to the area of the London Bills of Mortality. Three miles and more into the country they went from London and Westminster to abide in country houses at the charge of their parishes. A patrol of 5 nobles and 5 gentlemen saw to it that the children were fairly treated in their novel surroundings. The Acts of 1769 and 1773 sustain the humanistic note. The former established in St. George's Fields a home for penitent prostitutes. The latter promoted the better regulation of lying-in hospitals. The Act of 1792 is in the key of chivalry. It is an amending Act relating to rogues and vagabonds, but in the inevitable passage devoted to the subject of whipping the following long-delayed but welcome sentence appears: 'But a female, although convicted as a vagabond or incorrigible rogue, is in no case whatever to be whipped, any law to the contrary notwithstanding.'

Also in this reign came the Gilbert Act, denouncing the incompetent overseers and proposing instead that all power in the parish should be entrusted to one capable person. The able-bodied poor who are willing to work but cannot find work to do are entitled to apply to the guardian of the parish, whose duty it will then be to arrange suitable work for them near their places of residence. Until the work is made available, the guardian has to board and lodge the applicant at the public expense. The Gilbert Act is most remembered for the 'Incorporations,' or combinations of parishes, which it brought about.

Again under George III, an Act of 1795 disallows the removal of a poor person from any parish until he becomes actually chargeable. Further, if the poor person due for removal is sick when the day of departure comes, a justice may order suspension of the removal until it can be effected without danger. The Act of 1796 appeared in two parts. One enabled guardians to regulate assessments according to the price of wheat in Mark Lane. The other enabled relief to be given to any industrious poor person at his own residence, despite his refusal to accept a lodging in the 'parish house.' The relief order given by the justice was valid for a month, and two justices could extend it monthly for an indefinite period. This was unlimited outdoor relief, not as in 1722 with a test applied. The new way was everywhere misused and the poor rate rose.

Still in the reign of George III, in 1795, the Berkshire justices devised the Berkshire Bread Scale, or Speenhamland Act, in terms of which agricultural wages were to be graduated by the price of the gallon loaf of second flour. The scale, which was widely adopted, was reasonable in principle but disastrous in practice. What the justices should have done according to their own scheme was, when the price of bread went up, to order an equivalent rise in the wages of the labourers. What they did was to leave the wages undisturbed and to make up the equalising figure by drawing on the poor rates. This use of the poor rates in aid of wages pauperised whole communities, and the poor rate further rose.

In 1817 Lord Castlereagh said: 'In cases where 19s. or 20s. in the pound are paid for poor rates 15s. of that will be found to be wages paid in the shape of poor rates.' In 1818 the actual total was £7,870,801. A select committee, appointed to enquire, incriminated the settlement law with its endless litigation and false pleading.

In 1821 Mr. Scarlett, later Lord Abinger, proposed three bills which in sum were equivalent to the abolition of parish relief. A Welsh judge introduced a bill to restore its early purity as under Queen Elizabeth. None of these bills became law. All parties were fully aware of an impending crisis, but all were not agreed upon the way to avert it. Discussions however continued, the Hobhouse Act brought parish affairs more directly under the control of the ratepayers, and finally in 1832 a Commission was appointed to 'enquire into the administration and operation of the Poor Laws.' The scheme was aided by the distinguished support of Lord Melbourne, Lord Brougham and the Duke of Wellington.

The Commissioners presented their Report in 1834, containing what came to be known as the 'principles' of that year, which were as follows:

> To establish national unity of procedure under central control.
>
> No outdoor relief to be given to the able-bodied poor man and his family. For them the proper place is a well-regulated workhouse.
>
> Every local authority to maintain such a workhouse to which any able-bodied applicant can be consigned in order to test his destitution.
>
> The state of the able-bodied man, while receiving parish relief, to be made less eligible than that of an independent labourer.
>
> Children in workhouses to be kept apart from the aged and infirm in separate institutions where they could be educated by a schoolmaster.

The Poor Law Amendment Act followed hard on the Report, and normally would have given the principles the force of law but, owing to some imperfection in procedure, the question was left open and the Commissioners seem to have felt that they had a free hand. The only principle which they wholly honoured was the last but one in the list, which provides for the embitterment of the life of the pauper. Their crowning error was their neglect of the fifth and last principle relating to the workhouse. Instead of separating the sick paupers from the sound, and the young from the old, and giving each group a diversity of treatment according to its need their policy was to treat all together and all alike. They introduced this unhappy procedure into their General Consolidation Order of 1847. In the same year they were relieved of office by Act of Parliament.

Two useful Acts of this period, early in Queen Victoria's reign, were those of 1840 and 1846. The Act of 1840 was the Vaccination Act, under which guardians and overseers were directed to contract with one or more legally qualified medical practitioners for the vaccination of all persons resident in the union or parish, the amount of remuneration being determined by the number of successful vaccinations of persons not previously successfully vaccinated. The expenses of vaccination were to be defrayed out of the poor rates. Any person who inoculated or tried to inoculate with variolous matter or by any means whatever produced smallpox in any person in England, Wales or Ireland might on conviction be imprisoned up to one month. The selection of the poor law authorities to bear the cost was held to be justified by the fact that smallpox, when it breaks out, occasions much distress and destitution among the working classes. The Act of 1846 empowered guardians to take action against the owners or occupiers of filthy premises, this precaution being doubtless inspired by the third pandemic of cholera, which came in the year specified, sweeping all Europe, including England.

The Poor Law Board, to whom the duties of the Commissioners were now transferred, showed an especial interest in the sick and the young. They took the view that the sick poor should have as good a doctor as anybody else. They told the guardians to issue free supplies of quinine, cod liver oil and other costly medicines. Poor law dispensaries were thus established throughout London. For the sick poor in institutions, up till now ignored, hospital provision was made in various ways. The plan most favoured was that the hospital, though a part of the workhouse building, should form a separate unit, which developed in course of time into the Poor Law Infirmary.

The workhouses handed over to the Board by the Commissioners continued for a time to house the same motley host as before. Then, about 1865, the Board took action. They arrayed the formless multitude, grouping them by age or infirmity and keeping the groups apart in their appropriate quarters. At the same time, by their encouragement of the structural improvement of workhouses and other institutions they were conveying light and fresh air, comfort, amenity and sanitation into dark places.

The Poor Law Board were firm and enterprising in what they undertook. They revived the fifth principle of 1834. They raised the standard of treatment for all sick poor. In 1871 they were absorbed in a new creation.

The Local Government Board, who now took over from the Poor Law Board, stood for the principles of 1834. They attempted the reduction of outdoor relief, established workhouses for the able-bodied, and in general took up the position that discipline should be tightened.

Nevertheless they were sympathetic towards the unemployed wage earner. 'It is not desirable,' said their President, Mr. Chamberlain, 'that our working classes should be familiarised with poor law relief,' and guardians were recommended to arrange with local authorities for the execution of public works on which the unemployed could work for wages. Hence the foundation of Farm Colonies as at Hadleigh.

For the treatment of vagrants the Board urged national uniformity, the first principle of 1834. They discouraged outdoor relief to single women, deserted wives, the wives of men in gaol, and able-bodied widows with one child only.

In 1868, guardians had been directed to take proceedings against parents who neglected their children. In 1888 the Board reminded them of this duty, which they had evaded. The Act of 1889 suggested that guardians might see their way to defray the cost of prosecutions. A further Act of 1894 was more pressing. The throng of children on outdoor relief were sorely in need of the protection which these measures could have afforded, but the guardians stood idly by till 1904, when the right to prosecute was taken from them and handed over to County and County Borough Councils. The workhouse, however, still remained a 'place of safety' for children in danger.

The aggregated 'district' and 'barrack' schools having fallen into disfavour, the Board turned to smaller separate schools, cottage homes and detached buildings on a block system. In the scattered homes the children dwelt under the care of a matron or foster parent and attended the local public elementary school. The children in workhouses under school age were accommodated in separate hygienically planned nurseries. In 1904 the education of children in poor law schools was transferred to the Board of Education.

All boarded out children were now carefully supervised. All were due to be seen once a week by the relieving officer and visited once a quarter by the medical officer. No child was permitted to be boarded out in a house where any adult lodger slept.

The Board's frontal attack on outdoor relief made no exception of outdoor medical relief. At least they considered a report condemning it 'worthy of careful consideration.' In practice, however, they were more humane, and guardians were told that, even in the case of a person who had refused the workhouse, they were not to deny outdoor relief if the person was sick. Two years later we find them prepared to accord to any sick poor person under treatment at home not medical attendance only, but also skilled nursing. Institutional medical treatment, which had never been questioned for the sick poor, was made available also to sick members of the general public. In this way the poor law infirmaries came to render community service.

The Board from the first had tacitly withheld outdoor relief from the aged. Mr. Chaplin, however, in 1896 said that it was to be given. The question of 'indulgences' to old people in workhouses arose, and the Board, by general order, sanctioned an issue of tobacco. Other comforts happily followed in due course.

The Board accepted it as their bounden duty to differentiate their indoor paupers in separate institutions, thus restoring the fifth principle of 1834. This task was a heavy one, but they made good. They imposed a certain severity on able-bodied applicants for relief, especially such as belonged to the group of 'ins and outs,' but the rest were, for the most part, well housed in hygienic quarters with baths, sanitary fittings, towels, soap, changes of clothing and other conveniences. Their food was safeguarded by the Dietaries Order of 1900.

In the early years of the twentieth century shadows began to gather round the poor law. Once again it was deemed necessary to submit it to enquiry. The Royal Commission on the Poor Laws and Relief of Distress was accordingly called into being in 1905. In their report, which they presented in 1909, the Commissioners spoke with two voices (1) the majority report and (2) the minority report.

The majority report recommended the establishment of a new 'public assistance' authority, functioning as a destitution authority and so concerned with poor persons. The authority would be supported by a system of voluntary aid committees to whom certain classes would be permitted to apply.

The minority report recommended that 'prevention' should be the guide. Better, it said, to prevent destitution than to have to relieve it. What was required was to cure the social malady, of which destitution is the consequence, by applying to it the appropriate social remedy.

Such a remedy was, in 1908, the Old Age Pensions Act and, in 1911, the National Health Insurance Act.

In 1919, by the Act of that year, the Local Government Board, which had sheltered the poor law for close on half a century, was transferred with all its powers and duties, including the poor law, to the new-formed Ministry of Health.

In 1929, by the Local Government Act of that year, the local government of England underwent far-reaching changes, which in the case of the poor law authority reached as far as extinction. The Act speaks thus:

'The functions of each poor law authority shall be transferred to the county council and county borough council, and all poor law authorities shall cease to exist.

'Functions under the Children Act and functions relating to vaccination, formerly discharged by poor law authorities, are to be discharged by county councils and county borough councils.'

Every county council and county borough council was to submit to the Minister an Administration Scheme.

Such schemes might declare that any assistance which could be provided either by way of poor relief or otherwise should be provided exclusively otherwise and not by way of poor law relief.

Each council was to appoint a Public Assistance Committee. Two-thirds of the members of the Committee were to be members of the council. The county council was to divide the county into areas, and constitute for each a Guardian's Committee to deal with questions of relief.

So the inheritance of the extinguished poor law authority passes to the hands of others. Poor relief, in passing over, changes its name to 'public assistance,' which is the subject of the ensuing article.

PUBLIC ASSISTANCE

Public assistance is the residuary agency for the relief of persons who are not adequately cared for by other means. It is administered in England and Wales by the councils of counties and county boroughs, in Scotland by the councils of counties, counties of cities and large burghs, acting through public assistance committees and local guardians' committees. The assistance so rendered may be either domiciliary or institutional. It may take the form of either cash payments, issues in kind or medical and other services. It may be made available to the able-bodied, the non able-bodied and the sick. Local authorities who possess the necessary equipment, or are prepared to provide it, are at liberty in terms of the Local Government Act, 1929, in Scotland in terms of the Local Government (Scotland) Act, 1929, to declare that certain assistance services, which are capable of being rendered either under the poor law or under specified statutes relating to public health, shall be rendered by them under the latter.

Domiciliary. In the case of the destitute *able-bodied,* outdoor poor relief may be given in cash or in kind or partly in one partly in the other. Since the assistance of the able-bodied unemployed has been taken over by the Assistance Board, their outdoor poor relief is now very largely restricted to the comparatively small group of able-bodied unemployed who are in need but do not come within the scope of the Unemployment Assistance Act, because they have never followed an occupation in respect of which contributions were payable by way of insurance against unemployment, old age and other contingencies. In particular cases of this group the local authority may decide that the able-bodied person should be relieved not at home but within the workhouse.

In the case of the *non able-bodied* also outdoor poor relief may be given in cash or in kind or partly in each, as for the able-bodied. In particular cases relief may be offered in some other manner, for example in an institution suited to the special needs of the person. The assistance in these ways of the disabled and infirm, the aged, and widows and orphan children is now the principal activity of Public Assistance Committees. Many persons in this large group are receiving such relief in supplement of a pension or benefit under one or other of the social insurance schemes which has proved inadequate to meet their need. In the case of an insured employee and his sickness or disablement benefit, in the case of a widow under 60 years of age and her widow's pension, in the case of a child and its orphan's pension or in the case of a disabled workman and his workman's compensation, if the assistance so afforded falls short of requirements, public assistance in the form of outdoor poor relief can be made available.

In the case of the *destitute sick* at home public assistance, in addition to any reliefs in cash or in kind, may take the further form of domiciliary treatment by medical practitioners employed by the local authority. In some towns these practitioners are whole-time district officers whose work is restricted to this particular service. In large and densely populated cities with much aggregation of poor persons such a system has much to commend it. In smaller areas the district officers are usually on part-time duty and receive a salary with extra fees for special services. This plan also works well. If run on the panel system it allows the destitute sick to choose their doctor. An efficient domiciliary medical service for the sick poor has the advantage of relieving pressure on both public assistance institutions and voluntary hospitals. It cannot however be efficient without an adequate domiciliary nursing service, which must be regarded as a pre-requisite.

Institutional. Among the types of person eligible for admission to the public assistance institutions of a local authority may be included able-bodied persons, children, cases of chronic infirmity, cases of acute illness, maternity cases, mental cases, cases of infectious disease and cases suffering from contagious skin conditions. How many of these types will require to be provided for by the public assistance committee and how many by the public health or other committees of the local authority will depend upon the degree of completeness with which the public and other health services of the local authority have been organised so that, wherever there is a choice, action may be taken under public health or equivalent statutes in preference to the poor law. In a well-organised community, cases of infectious disease including tuberculosis, together with skin cases, mental cases and a good proportion of the maternity cases, will be dealt with by the public health committee, and if the area possesses well-equipped voluntary general hospitals many surgical and medical emergencies will normally be treated there. Under such conditions the principal types left on the hands of the public assistance committee will be the able-bodied, the children and the infirm from old age or chronic disease, along with such cases belonging to the other types as have been unable to be cared for by the agencies at disposal.

For *able-bodied* adults who are destitute and homeless, food and lodging may be provided in the workhouse. Casual wards are maintained at many workhouses for the reception of vagrants or men travelling in search of work. The casuals are taken in for one or more nights. Those fit to work are allotted tasks such as chopping wood.

For *children* provision is made according to age. Those under 3 may be accommodated in nursery units, sometimes attached to an institution such as an infirmary, but better separate so as to ensure sunlight and fresh air. Children of 3 to 16 years may be quartered in cottage homes which may be grouped under the charge of a superintendent. An alternative is to board the children out with suitable guardians, as may be done in the case of orphan or deserted children.

Persons rendered infirm by *age* should, if bed-ridden, receive medical care and nursing in the infirmary. Those who are able to move about should be housed in special homes or hostels, which may be arranged in such a manner as to give the aged person, or aged couple, as the case may be, the equivalent of a one or two-roomed house, the whole home or hostel being under the charge of a concierge and medical aid within easy call. Other old people who may be approaching invalidism are best housed in special wards where they can be kept under observation. Persons rendered infirm by chronic or disabling *disease* will often require skilled and careful nursing for which the infirmary is appropriate.

In order to meet the needs of acute medical and surgical cases for whom accommodation cannot be found elsewhere, a general *hospital* managed by the local authority may be required in some areas. Its staffing and equipment should be comparable with that of a voluntary hospital and it should, if possible, be in liaison with the voluntary hospital or hospitals in the neighbourhood. It is essential that there should be a maternity unit, preferably attached to the local authority hospital. Out-patient departments to treat all comers have been established in towns, some attached to a hospital, others functioning as independent and fully equipped health centres on a large scale. Such departments are able to deal with cases which might otherwise have required attention at home by a district medical officer or else have occupied a hospital bed. A convalescent home, if provided, will also liberate hospital beds, besides promoting recovery, especially from acute diseases.

MEDICAL PRACTICE

Most medical graduates and licentiates at some stage in their progress through life have come into touch, brief or lasting, with private medical practice, which in both its traditions and its main outlook typifies the 'healing art' by providing treatment.

Treatment, however, is not incompatible with prevention. The doctor's visits, though paid primarily with a view to treatment, may be caused to serve preventive purposes also. When the practitioner on his round tells his convalescent patient how to avoid another attack, or when he explains to the mother of a sick child what she should do in order to keep her other children well, he is giving preventive instruction to people whose minds at the moment are well attuned to receive it. The preventive value of any advice which he may offer will be enhanced by his growing acquaintance with the living conditions of his patients as he sees them in their homes, and by his resulting appreciation of the influence exerted by nutritional standards, occupation, housing, use of leisure and social factors generally on bodily and mental states.

Turning from the domestic scene to the field of Public Health or Community Hygiene, which is organised by local authorities and administered by their medical officers of health, we note that in this wider domain certain legal obligations are imposed upon the practitioner. It is his duty under statute to notify the occurrence of births to the medical officer of the welfare authority. By so doing he enables the officer to take such preventive action in the interests of the children as may be deemed appropriate. The practitioner is under obligation also to notify to the medical officer of health particulars regarding patients in his practice who are suffering from certain infectious diseases. On receiving such a notice the medical officer will say whether the case is to be removed to hospital or nursed at home and, with a view to preventing the further spread of the disease, will cause enquiry to be made as to the source of the infection. The practitioner is required also to notify cases of industrial disease which he encounters in his practice, in this instance not to the medical officer of his area but to an official of the Home Office in London.

While the local authority expects the practitioner to make the prescribed notifications, and is empowered, where necessary, to enforce its demands by legal process, its relations with him in other respects should be co-operative and, if so, will be useful to both the authority and himself. The authority establishes agencies which serve a public purpose, but which also help to lighten the practising doctor's work. By means of services conducted by the authority he may obtain consultations on his cases with experts in infectious disease or in obstetrics. To the authority's public health laboratory he may transmit, usually in an outfit supplied to him for the purpose, pathological exudates and body fluids for examination and report, in order to aid or confirm his diagnosis of diphtheria, tuberculosis, venereal disease and other conditions. Material for the treatment of disease may be issued to him by the authority free of charge, or nurses placed at his disposal for the domiciliary nursing of his patients, or health visitors sent to their homes with a view to the betterment of their environment.

The local authority also provides residential accommodation for sick persons in its area. Through the good offices of the authority in this field, the practitioner may be relieved of anxiety on behalf of those of his patients whose home conditions preclude effective medical treatment, or whose illnesses develop emergencies demanding special care or control. Destitute cases, infectious cases, ominous obstetrical cases, maniacal cases, convalescent cases requiring rest or change, cases in need of orthopoedic treatment and many other types may be received on his application into appropriate hospitals, homes or other residential institutions provided by the authority. The extent of the provision made varies from area to area. In general, where the need is greatest, the accommodation made available comes nearest to completeness. In order that he may secure for his patients the benefit of these public services the practitioner should know which of them have been put into operation in his area of practice. This information he may obtain from the medical officer of health.

For most of the medical services provided by local authorities it is appropriate that there should be a medical man or woman in charge. Examples are the superintendents of various hospitals and sanatoria and the officers in charge of such out-patient services as prenatal, infant, pre-school, school, or tuberculosis clinics. In the large institutions of populous areas the responsibility involved in such posts will be exacting enough to render a whole time appointment essential. Under these conditions there is no opening for the private practitioner, but in more sparsely peopled places with, say, a small hospital or a clinic that does not meet 'too often or too long' part-time service would frequently suffice and can be given by local practitioners. The same question as between the appointment of a whole-time officer and the employment of the local profession arises also in connection with the medical inspection of school children and the domiciliary treatment of the destitute sick Outside of services directly maintained by local authorities there are other salaried part-time positions for which the practitioner is eligible. One of these is the office of insurance medical practitioner. Another is the position of welfare medical officer in connection with a factory.

Such is medical practice in its relations with the public services at the time of writing, and such it is likely to remain until the substantiation of the National Health Service Act, 1946, for England and Wales, and the equivalent Act for Scotland. The National Health Service is to include (1) hospital and specialist services, (2) health centres and general practitioner (medical and dental) services, (3) various supplementary services, including midwifery, maternity and child welfare, health visiting, home nursing, vaccination and immunisation against infectious diseases, blood transfusion and laboratory services, and (4) the provision of medicines and appliances. Administration will be shared by the Minister of Health, in Scotland the Secretary of State for Scotland, existing local authorities and new *ad hoc* executive councils.[1]

The New Service will supersede the medical benefit which is at present available to persons insured under the National Health Insurance Acts, and it will involve the expansion and transformation of many other existing health services. It is not expected to come into operation before 1948.

PECKHAM EXPERIMENT

This essay in applied social medicine, now known as the Pioneer Health Centre, had its humble beginnings in 1926 in a small house at Peckham equipped with a consulting room, changing room, afternoon nursery and club room. By 1935 a specially designed building had been erected, possessing full clinical and laboratory facilities and providing also a social centre to serve the leisure of some 2,000 families.

On the recreational side of the enterprise are reading rooms, games rooms, badminton court, swimming pool and gymnasium. There are no management-planned activities within the club. 'Natural groupings form themselves round self-chosen interests, tracing their own social pattern.' The premises are of the most modern construction and partition walls are of glass. A well-equipped cafeteria is an essential feature. Of more medical significance are the orthopaedic department, the children's nursery and the examination and family consultation rooms.

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[1] Page 688.

For the payment of one shilling per week each family enrolled at the centre is entitled to a complete medical overhaul on joining and subsequently at yearly intervals. The thorough examination is both medical and dental and includes relevant laboratory tests. Later the results are explained at a family consultation (Fig. 210) during which every aspect of the family life which may have a bearing upon health is freely and frankly discussed. No therapeutic advice is given, but treatment, if desired, is arranged locally through the usual medical agencies. Facilities exist also for ante- and post-natal examinations. The need for such periodic medical examinations is clearly emphasised by the fact that of 1,200 persons dealt with at the centre, only 10 per cent. were free from discoverable disorder. One quarter of the remainder were found to be suffering from demonstrable disease, and of these only 30 per cent. were under treatment. In addition, many of the examinees were found to show a lowered vitality due either to social isolation or to domestic or occupational maladjustment.

Fig. 210.—Family Consultation at Peckham Health Centre.

The work at Peckham was largely brought to a standstill by the

Second World War, but it is now reviving. It is intended that, in the time to come, the Centre will, amongst its other duties, function as a training school for health educationists and others whose aim is the furtherance of a policy of positive health. It is not unlikely, moreover, that the Centre will, in part at least, serve as a model for the similar undertakings which are to be an integral feature of the National Health Service.

The history of the development of the Peckham Health Centre, together with details of its organisation, will be found in *The Peckham Experiment* by Innes H. Pearce and Lucy Crocker.

MINISTRY OF NATIONAL INSURANCE

This Ministry, which was brought into being by the Ministry of National Insurance Act of 1944, is destined in due course to assume charge of the National Insurance Act of 1946.[1] In the meantime the Ministry has taken over from various Government Departments existing schemes such as national health insurance (cash benefits), widows', orphans' and old age pensions, supplementary pensions, unemployment insurance, unemployment assistance and workmen's compensation. Some resulting changes in these services, indicating their position at present, are noted below.

NATIONAL HEALTH INSURANCE

The current contribution, which covers both National Health Insurance and Contributary Pensions, is 4s. per week in the case of men, being 2s. from the employer and 2s. from the employee, and 3s. 4d. per week in the case of women, being 1s. 8d. from the employer and 1s. 8d. from the employee. The insurance practitioner's remuneration by capitation fee is at the rate of 12s. 6d. per annum for each person on his list.

CONTRIBUTORY PENSIONS

The Contributory Pensions Scheme, which is compulsory for the same persons as are subject to national health insurance, together with certain others, is constituted in terms of the Widows', Orphans' and Old Age Contributory Pensions Act.

The widow of an insured person is due to receive a pension of 10s. per week (26s. if, being over 60 years of age, she has retired from regular employment, or if she is over 65) till re-marriage, or till she attains the age of 70, together with an allowance of 5s. per week for an only or eldest child. Orphans' pensions of 7s. 6d. per week are payable in respect of children who have lost both parents.

The old age contributory pension is 10s. a week beginning at 65 in the case of men and 60 in the case of women and continuing thereafter until age 70. If a contributory pensioner has retired from regular employment, or, in the case of a woman, has attained the age of 65 (whether or not she has retired from regular employment), the pension is raised to 26s. for a man or insured woman and 16s. for a married woman drawing pension along with her husband from his contributions.

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[1] Page 679.

At age 70 a contributory pensioner automatically becomes an old age pensioner having, however, this advantage over the non-contributory old age pensioner, that he is not subject to a means disqualification.

Payments of widows', orphans' and old age contributory pensions are made by means of vouchers cashable weekly in advance at a post office.

The contributions to the contributory pensions scheme are made by employed persons along with their contributions to the national health insurance scheme, by means of a weekly stamp which covers both. The amount of the joint contribution has been noted above.

OLD AGE PENSIONS

Pensions of 26s. for men and single women and 16s. for married women are payable at 70 to British subjects resident in the United Kingdom whose means do not exceed a specially calculated annual value of £26, 5s. In the case of blind persons, payment of the old age pension may begin at 40. As already observed, a contributory pensioner who attains the status of an old age pensioner at age 70 is entitled to receive his pension irrespective of his income. Furthermore, in the case of a married woman who is a contributory pensioner by virtue of her own insurance, the rate of old age pension is not 16s., but the 26s. which she has been receiving as contributory pension prior to age 70. The old age pensioner, like the contributory pensioner, is furnished with a book of vouchers, cashable weekly in advance at a post office, and each value in his case for an amount between 26s. and 2s., dependent on whether his yearly means as calculated do not exceed £26, 5s., or if above that figure do not exceed £89, 5s. In cases where the yearly means exceed £89, 5s., and the income test is appropriate, no old age pension is payable.

UNEMPLOYMENT INSURANCE

Payments, after suitable enquiry, are made to industrial workers weekly during unemployment at the rate of 24s. for men and 22s. for women, together with additional payments for accepted dependants. For a married woman living with her husband the rate is 20s.

UNEMPLOYMENT ASSISTANCE

For several years preceding 1931 the unemployment insurance scheme had found increasing difficulty in meeting the claims upon it. In order to cope with the large groups of unemployed men who had run out of benefit there was introduced towards the end of 1931 a system known as 'transitional payments' under which the men continued to receive payments from the unemployment insurance fund, but with this important difference that payments were only made after the local poor law authority had investigated the applicant's means and had determined that he was in need of assistance. The investigation and determination of this question of need by the poor law authority became notorious as the 'means test.'

The system of transitional payments was intended only as a temporary expedient to meet the emergency of 1931 and following years. In 1934 the whole procedure for the assistance of the able-bodied unemployed was put on a permanent footing by the passing into law of the Unemployment Assistance Act and the consequent establishment of the Unemployment Assistance Board. The functions of the Board were, *inter alia*, to take over from the unemployment insurance fund and the poor law authorities the business of granting assistance to able-bodied men who were in need on account of unemployment. In 1940 the Board's functions were extended to cover the administration of the Supplementary Pensions Scheme provided for in the Old Age and Widows' Pensions Act of that year. At the same time the Board's title 'Unemployment Assistance Board' was changed to 'Assistance Board.'

The scale allowances under the current Unemployment Assistance Regulations for applicants living as members of households are weekly as follows: for the householder and spouse 35s.: for the householder without spouse, if male 20s. 6d., if female 19s. 6d.: for other members of the household of 21 years or over, if male 14s. 6d., if female 13s. 6d.: and so on decreasing to 4s. 9d. for a child under 5. These allowances are paid in cash at the Employment Exchanges.

In reckoning up resources the following are disregarded: the first 5s. a week of sick pay from a Friendly Society: the first 10s. 6d. a week of benefit under National Health Insurance: the whole of any maternity benefit but excluding second benefit: the first £1 a week of any wounds or disability pension: one-half of any weekly payment by way of workmen's compensation: and the first 7s. 6d. a week of any superannuation payment.

The Assistance Board has a central office in London with district and area offices and out-stations throughout England and Scotland. Besides the granting of allowances to the unemployed, the Board has the duty of making provision for their welfare, improvement and re-establishment, and of bringing to bear upon households in need all the help that the social services, both statutory and voluntary, can supply.

CARE OF THE BLIND

The Blind Persons Act of 1920 requires every county and county borough council in England and Wales, and in Scotland every county council, council of the county of a city and council of a large burgh, to make arrangements for promoting the welfare of the blind, and with that object to provide technical education and maintain or support workshops, hostels and the like. A blind person under the Act is one who is 'so blind as to be unable to perform any work for which eyesight is essential.' It has been held that blindness of this degree is equivalent to visual acuity below $\frac{3}{60}$ Snellen. Each local authority is required to keep a register of the blind in its area, admission to which is obtained by certificate. In Glasgow and other centres in Scotland regional blind certification clinics have been established. Each case is examined by two ophthalmologists and then certified as to the degree of visual defect found.

The education of blind children has already been considered. For adolescents and suitable persons up to the age of 40 residential technical classes are available. Work may be done by the trained blind in special workshops under sighted supervisors. In some trades blind workers may be employed as packers. Other employments for the blind are typewriting, piano-tuning, music-teaching, massage, radiography, and certain home industries, but few of these who become blind after 50 can learn a handcraft.

A blind person may receive the old age pension of 26s. for men and single women and 16s. for married women per week at the age of 40, provided that the blind person's means do not exceed the specially calculated value. The Blind Persons Act, 1920, permitted local authorities to adopt schemes for the provision of domiciliary assistance to necessitous blind persons, but prior to the coming into force of the Local Government Act, 1929, few authorities had exercised these powers and consequently the relief of the destitute blind was a matter for the poor law. Since 1930, however, and by virtue of the Local Government Act, which encouraged local authorities, where assistance could be granted either by way of poor relief or under statutes other than poor law acts, to grant it under the latter, most authorities have adopted schemes under the Blind Persons Act for the provision of domiciliary assistance to the necessitous blind.

Under these schemes the income of a blind person aged 21 years and over is made up, on an average, to about 25s. per week if resident in an urban area or 18s. per week if in a rural area. In addition, a blind person in receipt of such assistance is usually granted free medical attention or treatment, and very often clothing each alternate year. By these provisions it is made possible for many of the necessitous blind to be cared for at home, which will usually be the preference of both themselves and their relatives.

In England and Wales in terms of the Public Health Act, 1936, and in Scotland under the Prevention and Treatment of Blindness (Scotland) Act, 1938, it is lawful for the appropriate local authorities to assist in the prevention of blindness, and in the treatment of persons suffering from disease or injury of the eyes.

Voluntary social service has done much for the blind, by the distribution of Braille literature, the provision of wireless sets, the issue of casual monetary grants and other aids.

ORTHOPAEDICS

The correction of physical deformities goes back to Hippocrates, the father of medicine, and terms like kyphosis and scoliosis for abnormal spinal positions are as old as Galen. It was in a much later age that Ambroise Paré, the father of modern surgery, made use of perforated metal corselets to readjust distortions of the spine. From this modest beginning on the fringes of surgery the corrective art grew and flourished with the result that now as 'orthopaedic surgery' it ranks among the constituent specialisms of surgery itself. The original art appears to have been nameless till 1757 when Nicolas André called his book 'L'Orthopédie.' At the same time he defined the word as meaning 'the art of preventing and correcting bodily deformities in children.' André held that the preventive approach was much superior to the corrective, but the unquestioned successes of orthopaedic surgery since his time threw correction into high relief and left prevention in the shadow. To-day however the tide of opinion is setting back towards André's view, and the importance of the prevention of deformities is increasingly recognised.

Cripples are physical defectives who suffer from deformity or impairment of function of the spine or limbs. The crippling flaw may be congenital, as in the cases of talipes, hip dislocation and torticollis. Or the lesion may develop from a bacterial or other infection, as in spinal or joint tuberculosis, osteomyelitis and infantile paralysis. Further causes of crippling are rickets, non-tuberculous spinal curvature, as in postural scoliosis, rheumatoid or other arthritis, severe flat-foot, ill-united fracture after injury and contracture following on a burn. The number of cripples in England and Wales has been put at 8·7 per thousand of population and at 9·9 per thousand of school children. An orthopaedic hospital was founded in Birmingham in 1817. In 1900 the opening of the Baschurch Home, later to become the Robert Jones and Agnes Hunt Orthopaedic Hospital, marked the beginning of the modern orthopaedic institution. Since then action for the care of cripples has not been lacking in England. Recent benefactions by Lord Nuffield have notably aided progress, and the Central Council for the Care of Cripples and the Scottish Orthopaedic Council have rendered service by focussing opinion and stimulating authorities towards putting schemes into operation.

Schemes. A well-devised orthopaedic scheme should be under the general direction of an expert orthopaedic surgeon. Its capital building will be its orthopaedic hospital, fully equipped and suitably staffed with orthopaedically trained surgeons, physiotherapists and nurses. The hospital should be sited in the open country. It should be of spacious dimensions and should include a hospital school and hospital workshops. The scheme should comprise also out-patient clinics, convenient of access. The clinics may be staffed and equipped for diagnosis or treatment or both, and they may be used as consultation centres by the orthopaedic surgeons. Such is the basic structure. It should however be a flexible structure, fitting in with local conditions. Where there exist in a scheme area general and children's hospitals already making competent provision for groups or types of cripples, there should be no thought of setting up a rival service, but the scheme should be adapted to work in co-operation with these institutions, with the addition under the scheme of such further facilities as may be deemed necessary to co-ordinate the whole. It would be desirable, wherever possible, that scheme hospitals should be grouped so as to centre on a teaching general hospital, for clinical guidance, transfer of cases and other purposes.

Orthopaedic schemes may be either voluntary or rate-aided. If the former, they will usually be financed by private generosity, as already referred to. If the latter, they will be founded and maintained by local authorities. With a view alike to efficient working and financial stability, schemes now operating or proposed tend to be on the grand scale, county-wide if the county is large enough, or regional, that is to say, made up of a substantial block of adjacent counties, or even for certain purposes national covering the whole country. A well-devised scheme, however composed, will aspire to provide for the people in its area a complete orthopaedic service for (1) Prevention, (2) Rehabilitation and (3) After-care.

Prevention in orthopaedics is usually not so much an effort to forestall a lesion, so that it never comes into existence, as one to prevent or mitigate the related deformity. Given timely care, 90 per cent. of deformities can, it is claimed, be cured. If treatment is delayed the deformity gets worse and strikes its roots deeper. In the end it becomes fixed, beyond the hope of cure. Early treatment is obviously the pre-requisite. To round up likely cases the authority in charge of the scheme must be in a position to find them. But, unfortunately for the object in view, cripples as a class are not notifiable. Infants with congenital lesions may have been reported from the local maternity service, or pre-school children from the nursery schools. Others, of school age, have been brought to light by medical inspection, often with established deformities dating from their pre-school period. Many of the urgent child cases however are unknown to the authority, and have still to be 'ascertained.' In order to reveal the actual incidence of deformity, and who and where the cases are, and at the same time to create an atmosphere favourable to remedial action, a campaign of propaganda combined with enquiry should be promoted in the area. The promoters should enlist the co-operation of the local doctors and nurses, women's institutes and social and other workers, to spread a belief in the art of orthopaedics and confidence in its works. This plan has proved successful at Oswestry and elsewhere. A scheme, once started, will by means of its hospital and clinics exercise an educational influence and also help to improve the round-up. Doctors in practice will know that a remedy is now available. When parents realise that there are places near at hand where their afflicted children may be cured they will not be slow to bring them.

The initiative to prevent however is not always in the hands of either practitioners or parents. With poliomyelitis, which involves the risk of paralysis, responsibility for delay may rest with the infectious diseases hospital to which the child was removed. The case is retained in the hospital as long as it is presumed to be infective, and may be seen by an orthopaedic surgeon only after its discharge, by which time the paralytic defect may have made damaging progress. All cases of poliomyelitis should be placed under orthopaedic supervision as soon as recognised. All large infectious diseases hospitals should have an orthopaedic surgeon on their staff.

It should be added that local authorities may take mass preventive action of various kinds which will operate against certain disease conditions liable to lead to deformity. It is mass prevention when a local authority ensures the use of tuberculin tested or pasteurised milk to the children in its area, and so prevents among child consumers spinal or joint tuberculosis of bovine origin. It is mass prevention again when an authority improves housing conditions by letting in air and sunshine upon children or provides them with vitamin-charged foods, and so saves them from rickets. Such measures, where successful, will within their own range tend to relieve orthopaedic schemes of a number of cases which would otherwise have claimed attention.

Rehabilitation in orthopaedics is often a slow process, its duration being measurable in months or years. Hence the spacious accommodation provided in orthopaedic hospitals. In other cases the patient's treatment only begins in the hospital and is then made over to a clinic near his home, at which he attends periodically for observation or further treatment until his correction or restoration of function is at last complete, or as good as it can be made. Early or slight cases seen at a clinic by the consulting orthopaedic surgeon may continue to be treated there without being sent to the hospital at all. It is thought important that every clinic should be supported by a system of follow-up home visiting. Trained nurses need not be detailed for this duty. The service should be voluntary, given by local women of good disposition, who will make sure that the children show up at the clinic, see to it that their splints or other appliances are properly used and kept in repair, and endeavour in every way to develop mutual trust between the clinic and the home.

The Hospital School is an essential constituent of the orthopaedic hospital, where children have to be in residence for long periods. Many of them are alert-minded and probably all have faculties which should not rust unused. The mental exercises strongly aid the process of physical treatment, and in the long run improve the child's prospects of suitable employment at some future time.

The Hospital Workshops are for the purpose of giving vocational training to adolescent cripples in order that, when discharged, they may have acquired aptitudes which will stand them in useful stead when seeking remunerative employment, either in the open market if their cure has been sufficiently complete, or under sheltered conditions if they are still partially disabled. A large proportion of present-day cases of severe crippling are in receipt of public assistance relief, having entered upon the dependent life at comparatively young ages.

Orthopaedic hospitals should maintain links with the fracture or rehabilitation departments of the general hospitals in their area, which receive persons injured by industrial or other accidents. Time presses at the general hospital while such patients await the slow restoration of function in beds urgently needed for acute cases. Their transference to the orthopaedic hospital, where time stands still, holds out the tranquil promise of final cure.

After-care by trained social workers, preferably almoners, who understand the special problems of the orthopaedic patient, is much needed. They should be experienced in assessing home conditions, both social and economic, and should be competent to offer vocational guidance to those patients who are about to begin or resume work. The almoners should in general act as liaison officers between home, hospital and school or factory. They can do much, by enlisting the aid of school teachers and employers, to smooth the way for the patient, and they should be at hand with encouragement when things seem to go badly for him.

In England and Wales the appropriate local authorities are empowered by the Public Health Act of 1936 to establish orthopaedic schemes as outlined above. Scots law does not go so far.

NATIONAL INSURANCE ACT, 1946

This Act provides cash payments in respect of periods of incapacitating sickness and of unemployment, maternity, widowhood, guardianship of orphans, old age and death. It will supersede the present schemes of national health insurance (cash benefits), widows', orphans' and old age contributory pensions, and unemployment insurance, but is not expected to come into operation before 1948.

Weekly contributions under the Act will be compulsorily payable by all members of the community, except children, retired persons, married women who have elected not to contribute, and certain other small and unimportant groups. In addition, employers will be required to pay employers' contributions in respect of their employees. The State will add Exchequer contributions to all contributions paid by insured persons and employers.

Insured persons will fall into one or other of three classes, according to their circumstances in the matter of employment, *viz.*, (1) employed persons (*i.e.*, persons working for an employer), (2) self-employed persons (*i.e.*, persons working on their own account), and (3) non-employed persons. The benefits for which a person will be eligible and the rates of contribution payable by him will depend on his classification, the underlying principle being that a person shall contribute, and shall be eligible only for such types of benefit as are appropriate to his needs, having regard to his employment status. Thus employed persons will be eligible for all the benefits of the scheme, self-employed persons for all benefits except unemployment benefit, and non-employed persons for all benefits, except sickness benefit, unemployment benefit, and maternity allowance. Maternity grant and attendance allowance will, however, be payable.

Contributions. The rates of weekly contribution, including, in the case of employed persons, the contributions payable under the Industrial Injuries scheme, are as follows:

	Employed Persons.						Self-employed Persons.		Non-employed Persons.	
	Employee.		Employer.		Total.					
Men	s.	d.	s.	d.	s.	d.	s.	d.	s.	d.
18 and over	4	11	4	2	9	1	6	2	4	8
Under 18	2	10½	2	5½	5	4	3	7	2	9
Women										
18 and over	3	10	3	3	7	1	5	1	3	8
Under 18	2	4	1	11	4	3	3	1	2	3

(1) In the case of employed persons of 18 and over who are earning low wages the employee's contribution is less and the employer's contribution correspondingly more.

(2) Out of each contribution paid by an insured person under the National Insurance Act a payment is to be made to the Exchequer in respect of the cost of the national health service. The payments will be 10d. (man), 8d. (woman), and 6d. (boy or girl under 18).

(3) For each contribution paid by an employed person, employer, self-employed person, or non-employed person, a supplementary contribution will be paid by the Exchequer.

(4) After five years the contributions of employees and employers will be increased by 2d., and those of self-employed and non-employed persons by 4d. (1d. and 2d. respectively for persons under 18).

Benefits:

Sickness Benefit and *Unemployment Benefit* for a man or a single woman will be at the rate of 26s. a week, with an addition of 16s. for a non-gainfully occupied wife or other adult dependant, together with a further 7s. 6d. for the first, or only, child in the family. In the case of a married woman who is herself insured as an employed or self-employed person, and living with or financially assisted by her husband, the rate of sickness benefit is 16s. while unemployment benefit (employed persons only) is 20s. a week. Where, however, such a woman is maintaining an invalid husband or is living apart from and not being financially assisted by him, the full rate of 26s. is payable, together with, in the first case, 16s. for the husband. An unmarried person under 18 without dependants receives a reduced rate of 15s. a week.

Maternity Benefit comprises a *Maternity Grant* of £4 to wives of insured men, and to other women who are contributors (£8 in the case of twins). together with either (1) an *Attendance Allowance* of £1 a week for four weeks to women who are neither employed nor self-employed persons, or (2) a *Maternity Allowance* of 36s. a week for thirteen weeks to employed and self-employed women.

Widows will receive a *Widow's Allowance* of 36s. a week for the first thirteen weeks of widowhood, with a further 7s. 6d. if there is one or more dependent children. This will be followed either by (1) a *Widowed Mother's Allowance* of 33s. 6d. a week, including 7s. 6d. for the only or first child, if, and for so long as, the widow has dependent children, followed in turn by a *Widow's Pension* of 26s. a week on termination of the widowed mother's allowance if she is then over age 40 and not less than ten years have elapsed since marriage: or (2) a *Widow's Pension* of 26s. a week if, having no dependent children, the widow was over 50 when her husband died and had been married for not less than ten years. Certain relaxations of the conditions for widow's pension apply to widows who are incapable of self-support by reason of infirmity.

Guardians of children who have lost both parents will receive for each child a *Guardian's Allowance* of 12s. a week under the National Insurance Act, in lieu of payments under the Family Allowances Act.

Retirement Pensions will be payable at or after age 65 for men and 60 for women on retirement from regular work, or at age 70 for men and 65 for women irrespective of retirement. The normal rate for an insured man or an insured woman is 26s. a week. Where a married man is of pensionable age but his wife is not, his pension may be increased by 16s. to 42s. a week: if the wife is also of pensionable age, the 16s. is paid to her as a separate pension. Where the wife is herself insured and of pensionable age she will draw a 26s. retirement pension from her own insurance, instead of 16s. from her husband's insurance.

In the case of employed and self-employed persons, the rates of retirement pension may be increased if retirement is deferred. The increment is 1s. a week for every 25 contributions paid beyond the minimum pensionable age, the maximum pensions obtainable being 36s. for men and 26s. for uninsured wives.

Death Grant. A death grant to meet funeral expenses will be payable on the occasion of the death of an insured person or the dependent of an insured person. The amount of the grant will be £20 for an adult and sums varying from £6 to £15 for persons under 18. Certain restrictions and limitations apply to persons of advanced and young age at the beginning of the scheme.

Benefit Conditions. Title to benefit is dependent on the satisfaction of certain contribution conditions, non-satisfaction involving reduction or forfeiture of benefit. Certain benefits, *e.g.*, retirement pension prior to age 70 (man) and 65 (woman), are subject to reduction on account of earnings.

Administration. The administration of the National Insurance Act is vested in the Minister of National Insurance, assisted by central and local advisory committees. The 'Approved Societies' which have been a feature of the existing national health insurance scheme are to be abolished: they will be replaced by local offices of the Ministry of National Insurance, to be set up throughout the country. Appeals against decisions given in particular cases by the Minister or his officers may be made to appeal tribunals, or in limited classes of case to the Courts. The Minister has been given extensive powers to make regulations modifying the provisions of the Act in relation to special classes of persons, providing for the transition from existing insurance schemes to the new scheme, and dealing with many matters of detail not fully provided for in the Act itself.

Old Age Pensions. The arrangement whereby a person who has not qualified for an old age pension as a national insurance contributor may obtain such a pension at age 70 if his means fall within certain prescribed limits is being retained, as is also the similar scheme whereby blind persons may obtain blind pensions at age 40 on the same conditions.

NATIONAL INSURANCE (INDUSTRIAL INJURIES) ACT, 1946

This Act provides by means of a scheme of State insurance for money payments being made where disablement or death results from injury sustained in the course of employment. The scheme differs fundamentally from the scheme of Workmen's Compensation which it will replace. Under the latter scheme the compensation is a liability imposed by law upon the employer, against which he usually insures himself by means of a policy with a private Insurance Company, or similar security. Under the new scheme the compensation will be provided out of an Industrial Injuries Fund, under the control and management of the Minister of National Insurance, which will be maintained by weekly contributions compulsorily paid by the employer, the employee and the Exchequer. Furthermore, whereas under the Workmen's Compensation Scheme the compensation was based on the loss of earning capacity and had to be specially calculated in each individual case, under the Industrial Injuries Insurance Scheme it will take the form of benefits at flat rates, with supplements for dependants. It is not anticipated that the Act will come into operation before 1948.

The persons insured under this Scheme will be all persons who work for employers under a contract of service or apprenticeship (the 'employed persons' of the main National Insurance Scheme). Children are included, subject to special conditions, although no contributions are payable in respect of them while they are under school leaving age.

Contributions. The rates of weekly contribution are 4d. for a man, 3d. for a woman, 2½d. for a boy and 2d. for a girl under age 18. The employer is required to make payments at the same rates, and the Exchequer contributes sums equal to one-fifth of the proceeds of the contributions of employer and employee. The employer's and employee's contributions will be paid along with the contributions due under the general National Insurance Scheme by the affixing of a single stamp weekly by the employer to a contribution card. The sums referable to Industrial Injuries contributions will, however, be separated from the National Insurance contributions and paid into the Industrial Injuries Fund, as already stated.

Conditions for Benefit. An industrial injury is defined as personal injury caused on or after the appointed day by accident arising out of and in the course of insurable employment. The following accidents are included, subject to certain conditions, *viz.* (1) an accident which occurred at a time when the insured person was acting in contravention of statutory regulations, or of any orders given by or on behalf of his employer, (2) an accident which occurred while the insured person was, with the express or implied permission of his employer, travelling to or from his place of work as a passenger by a vehicle operated by or on behalf of his employer (otherwise than as a public transport vehicle), and (3) an accident which occurred when the insured person was dealing with an emergency. Furthermore, there is no disqualification, such as was contained in the Workmen's Compensation Acts, in respect of an injury attributable to the serious and wilful misconduct of the employee.

Title to benefit is not (as in the main National Insurance Scheme) dependent on the insured person's contribution record.

Benefits. There are three classes of benefits, *viz.* (1) Industrial Injury Benefit—payable during a period immediately following an industrial injury if the injury has caused incapacity for work: (2) Industrial

Disablement Benefit—payable in cases of permanent or substantial disablement due to an industrial injury: and (3) Industrial Death Benefit, payable to widows, children, or other dependants where the breadwinner has died as a result of an industrial injury. The system of benefits has been founded largely on that applicable to members of the Forces and civilians who suffered injury or death in the late War.

Industrial Injury Benefit. The rate of this benefit is 45s. a week (33s. 9d. for persons of 17 years of age, and 22s. 6d. for those under 17). It is payable in respect of incapacity for work resulting from the injury, and may continue for a maximum period of six months. An additional 16s. a week is payable for a wife or other adult relative maintained by the beneficiary, and a further 7s. 6d. for the first or only child in the family. The benefit takes the place of the sickness benefit payable under the main National Insurance Scheme for incapacity for work due to ordinary illness or non-industrial injury.

Industrial Disablement Benefit. At the end of the period of industrial injury benefit, the insured person may be awarded industrial disablement benefit, if, as a result of the relevant injury, he is suffering from loss of physical or mental faculty which either is likely to be permanent or is substantial. The amount of benefit will depend on the extent of the disablement as assessed by a Medical Board. Where the disablement is assessed at 100 per cent., an industrial disablement pension of 45s. a week will be awarded: for lesser degrees of disablement the pension will be proportionately less. An industrial disablement pension at a particular rate may be awarded for a limited period (short or long), or for life, according to the length of time the claimant is expected to suffer from the assessed degree of disablement. Persons under 18 years will receive reduced rates of pension, and persons whose disablement is assessed at less than 20 per cent. will receive a lump sum gratuity instead of a disablement pension.

In most cases a person who has been awarded an industrial disablement pension will not be incapacitated by his disability from working and earning wages. Normally, therefore, the pension will not require to be supplemented by dependants' allowances. If, however, the beneficiary is entitled to an unemployability supplement because he is permanently incapable of work (see below) or if he has to enter hospital for treatment for his injury, the usual additions of 16s. for a wife or other adult dependant relative, and 7s. 6d. for a child, will be payable. If the beneficiary suffers from incapacitating sickness or is unemployed, he will not be disqualified by his disablement pension from drawing sickness or unemployment benefit (with allowances for dependants) under the main National Insurance Scheme.

A person in receipt of a disablement pension who is permanently incapable of work as a result of his injury will receive an 'unemployability supplement' of 20s. a week (lower rates for persons under 18), and a person with a 100 per cent. disability pension whose condition is such that he requires constant attendance will receive an increase of pension not exceeding 20s. or, where the disablement is exceptionally severe, not exceeding 40s. a week.

A person whose disablement pension is less than the 100 per cent. rate may have it increased by the sum of 11s. 3d. a week (provided that the resultant rate does not exceed 45s.), if his disability, though perhaps not serious in extent, is yet of such a nature as to prevent him from following his former occupation, or another occupation equally remunerative and suitable.

Industrial Death Benefit. Where the insured person dies as a result of an industrial injury, his widow will receive a pension of 30s. a week if she is left with one or more children, together with 7s. 6d. a week for the eldest or only child. The same rate of 30s. will also apply to widows over 50 years of age, and to those who at the date of their husband's death were permanently incapable of self-support. In other cases the rate of widow's pension will be 20s. a week. In all cases a temporary allowance at the rate of 36s. a week will be substituted for the pension during the first thirteen weeks after the death.

A widower who had been maintained by his wife may receive a pension of 30s. a week if the wife dies as the result of an industrial injury.

There is also provision for the payment, subject to the satisfaction of certain conditions, of pensions, gratuities, or allowances to dependent parents or other relatives of deceased persons.

Industrial Diseases. The benefits provided by the National Insurance (Industrial Injuries) Act for cases of personal injury by accident will be equally available where disablement or death results from any prescribed industrial disease, or from any prescribed personal injury due to the nature of the insured person's employment and developed on or after the appointed day. The necessary prescribing of diseases and injuries will be done in regulations made by the Minister of National Insurance. It is anticipated that they will be generally on the lines of the corresponding provisions of the present Workmen's Compensation Acts, and Orders made under these Acts. The regulations may prescribe a disease or injury either generally or in relation to persons engaged in a particular occupation.

The Act enables special arrangements to be made regarding pneumoconiosis, similar to those which are now in operation under the Workmen's Compensation Acts. The existing definition of pneumoconiosis is retained, *viz.*, ' fibrosis of the lungs due to silica dust, asbestos dust or other dust, including the condition of the lungs known as dust-reticulation.' Thus the term covers silicosis, asbestosis, etc. It is also provided that, where a person is found to be suffering from pneumoconiosis accompanied by tuberculosis, the effects of the tuberculosis shall be treated as if they were effects of the pneumoconiosis.

Administration. The Industrial Injuries Insurance Scheme will be administered separately from the main National Insurance scheme. While the Minister of National Insurance will be responsible for both schemes, he will make separate appointments of insurance officers, appeal tribunals, medical boards, etc., for the purpose of the Industrial Injuries Act, all in terms of the special provisions of that Act. Similarly, a separate central advisory council will be appointed to advise the Minister in the exercise of his powers under the Act. It is, however, anticipated that the administration of the two schemes will be integrated to the fullest possible extent, and that the same local offices of the Ministry will deal with claims for benefit under both Acts.

In addition to his duties under the Industrial Injuries insurance scheme proper, the Minister of National Insurance is empowered to promote research into the causes and incidence of, and methods of prevention of, accidents, injuries and diseases, and to make arrangements to secure the provision and maintenance, free of charge or at a reduced charge, of equipment and appliances such as artificial limbs.

As in the case of the main scheme, the Minister is given power to make regulations dealing with a great variety of matters of detail arising under the Act.

NATIONAL HEALTH SERVICE ACT, 1946.

1. Under this Act it will be the duty of the Minister of Health to promote the establishment in England and Wales of a comprehensive health service designed to secure improvement in the physical and mental health of the people of England and Wales and the prevention, diagnosis and treatment of illness, and for that purpose to provide or secure the effective provision of services in accordance with the Act. The services so provided will in general be free of charge.

2. There is to be a Central Health Services Council, referred to as the Central Council, to advise the Minister. In terms of the First Schedule to the Act the Central Council will have as *ex officio* members the President of each of the Royal Colleges of Physicians, Surgeons and Obstetricians, together with the Chairman of the Council of the British Medical Association, the President of the General Medical Council and the Chairman of the Council of the Society of Medical Officers of Health. Of the 35 appointed members 15 will be medical practitioners of whom 2 must have knowledge of mental illness and defect, 5 will be lay persons experienced in hospital management, other 5 will be lay persons experienced in local government, 3 will be dental practitioners, 2 will be persons experienced in mental health services, other 2 will be registered nurses, 1 will be a certified midwife and the final 2 will be registered pharmacists.

The Minister may, after consultation with the Central Council, constitute Standing Advisory Committees to advise the Minister and the Central Council on matters relating to the services with which they are concerned.

3. As from the appointed day it will be the duty of the Minister to provide hospital accommodation, medical and nursing services, likewise the services of specialists whether at a hospital, health centre or, if necessary on medical grounds, at the homes of patients. Regulations may provide for the payment of the travelling expenses incurred by patients, including a companion.

5. Accommodation in hospital may be provided for private patients

who undertake to defray the cost of their treatment. The Minister may allow any medical practitioner on the staff of a hospital providing hospital and specialist services to make arrangements for the treatment of his private patients either at the hospital or any other such hospital, and may make special accommodation available for that purpose. In that event the charges prescribed shall not include the practitioner's fee, for which regulations will be made determining the maximum charges.

6. On the appointed day all voluntary hospitals, with certain exceptions, are to be wholly transferred to and vested in the Minister. So also all hospitals vested in a local authority.

7. All endowments of a voluntary hospital designated by the Minister to be a teaching hospital, if held by the hospital immediately before the appointed day, shall on that day be transferred to and vested in the Board of Governors of the hospital.

Under certain conditions an endowment may be transferred to a fund established by the Minister to be called the Hospital Endowments Fund. Under certain other conditions the endowment must be transferred to the Hospital Management Committee of the hospital or group of hospitals.

8. Where a medical or dental school is associated with any hospital to which section 6 applies, any property or liabilities held or incurred solely for the purposes of the school shall be transferred to the governing body of the school, not of the hospital. The same exception applies to any institute for the post-graduate teaching of medicine or dentistry associated with a hospital.

11. The Minister shall by order constitute Regional Hospital Boards for the administration of hospital and specialist services in defined areas. Within these areas Hospital Management Committees will function for the management of individual hospitals or groups of hospitals other than teaching hospitals.

After consultation with the University concerned the Minister may designate as a teaching hospital any hospital or group of hospitals which appears to him to provide for any University facilities for undergraduate or post-graduate clinical teaching. Such a hospital will be administered by its Board of Governors.

14. All officers employed by any hospital providing hospital and specialist services, other than a teaching hospital, shall be officers of the Regional Hospital Board. All officers employed by a teaching hospital shall be officers of the Board of Governors. The remuneration and conditions of service of all officers shall be determined by the Regional Hospital Board or the Board of Governors as the case may be.

16. The Minister may conduct, or by grants or otherwise assist, research into the causation, prevention, diagnosis or treatment of illness or mental defect. The Board of Governors of a Teaching Hospital and a Regional Hospital Board and a Hospital Management Committee are also empowered to conduct research in those fields. The Minister may provide a bacteriological service, with laboratories, for the control of infectious disease. He may acquire supplies of human

blood for blood transfusion, or hold consignments of preparations for issue in emergency to local health authorities and medical practitioners.

19. For the purposes of the Act the Local Health Authority shall for each county be the council of the county, and for each county borough the council of the county borough. A joint Board may be established for the areas of two or more local health authorities.

20. All Local Health Authorities shall submit to the Minister proposals for carrying out their duties. If any authority fails to do so the Minister will arrange. Every Local Health Authority shall establish a Health Committee to which all matters relating to their functions, borrowing and rating excepted, shall stand referred.

21. The services which the Local Health Authorities are due to provide and maintain are listed under the following titles: health centres, care of mothers and young children, midwifery, health visiting, home nursing, vaccination and immunisation, ambulance services, prevention of illness and care and after-care, and domestic help.

31. In the area of every Local Health Authority there shall be constituted an Executive Council, with a chairman appointed by the Minister, which will exercise functions with respect to the General Medical Services.

32. Within the area of an Executive Council the Minister may recognise a Local Medical Committee, a Local Pharmaceutical Committee or a Local Dental Committee for the area concerned.

33. The main duty of an Executive Council will be to enter into arrangements with general medical practitioners in accordance with regulations to be made by the Minister. These regulations may cover the adequacy of services given, the publication of lists of entrants, the free choice of doctor by patients, the limitation of the number of patients accepted, the allocation of patients refused by individual practitioners and the issue of medical certificates.

34. Only a medical practitioner engaged in medical practice otherwise than as a paid assistant is entitled to give General Medical Service under the Act, provided always that before the appointed day he has applied to the Executive Council of his area to be included in their approval list. On or after the appointed day any practitioner who wishes to join or to change to a new area must obtain the consent of the Medical Practices Committee, a body composed wholly or largely of medical practitioners. The Medical Practices Committee may refuse an application on the ground that the number of qualified applicants is already adequate for the area. When the number of applicants exceeds the number of vacancies the Committee will select the practitioner or practitioners to be accepted. A practitioner whose application has been refused may appeal to the Minister.

35. It is unlawful under the Act to sell the goodwill of the practice of a practitioner who had entered the service on or after the appointed day. The penalty on conviction is a fine of such amount as will secure that no benefit is derived and the further amount of

five hundred pounds, or imprisonment up to three months, or both fine and imprisonment.

A practitioner can learn in advance from a Medical Practices Committee whether in their view a contemplated transaction would be a sale of goodwill.

36. Medical practitioners who joined the service at the outset will be entitled to compensation in respect of the loss incurred through being unable to sell their practice. The aggregate amount of compensation for which provision is made is £60,000,000, to be apportioned between England and Wales on the one hand and Scotland on the other.

37. The practice of a practitioner who has retired or died between the passing of the Act and the appointed day, and the goodwill of the practice has not been sold in whole or in part, may if the Medical Practices Committee approves likewise qualify for compensation.

38. It shall be the duty of every Executive Council to make as respects their area arrangements for the supply as from the appointed day, whether at a health centre or otherwise, of proper and sufficient drugs and medicines and prescribed appliances to all persons in the area who are receiving General Medical Services, and of prescribed drugs and medicines to all persons in the area who are receiving dental services. These arrangements are referred to in the Act as Pharmaceutic Services.

Regulations may make provision for securing that any person receiving General Medical Services can obtain proper and sufficient drugs and medicines and prescribed appliances, if ordered by the medical practitioner, from any persons with whom arrangements have been made. Similar procedure applies in the case of a person receiving general dental services.

Lists must be published of persons who undertake to provide pharmaceutical services.

39. These persons must be either registered pharmacists or authorised sellers of poisons within the meaning of the Pharmacy and Poisons Act of 1933, who undertake that all medicines supplied by them shall be dispensed either by or under the direct supervision of a registered pharmacist or by a person who for three years immediately before 16th December, 1911, had acted as a dispenser to a medical practitioner or a public institution.

40. It shall be the duty of every Executive Council to make as respects their area arrangements with dental practitioners under which as from the appointed day any person in the area for whom a dental practitioner undertakes to provide dental treatment and appliances, whether at a health centre or otherwise, shall receive such treatment and appliances. These arrangements are referred to in the Act as General Dental Services.

Regulations may make provision for the publication of lists of dental practitioners who undertake to provide General Dental Services.

41. It shall be the duty of every Executive Council to make as respects their area arrangements with medical practitioners having the prescribed qualifications, ophthalmic opticians and dispensing opticians, for securing as from the appointed day the testing of sight by such

medical practitioners and opthalmic opticians, and the supply by ophthalmic opticians and dispensing opticians of optical appliances. These arrangements are referred to in the Act as Supplementary Ophthalmic Services.

The functions of an Executive Council under this section will be exercised on behalf of the Council by a Committee to be called the Ophthalmic Services Committee.

42. A Tribunal of Three is to be set up to investigate cases where a representation is made either by an Executive Council, or if the Tribunal thinks fit by any other person, that the continued inclusion of certain persons in a list prepared by the Council would be prejudicial to the efficiency of the service The Tribunal will consist of a chairman together with an appointed and a professional member. The chairman will be either a practising barrister or a solicitor of not less than ten years' standing approved by the Lord Chancellor. The appointed member will be appointed by the Minister as a person representative of Executive Councils. The professional member will be one of a panel of six, namely a medical practitioner, a dental practitioner, a registered pharmacist, a medical practitioner practising as an oculist, an ophthalmic optician and a dispensing optician. One of the six must be of the same profession as the person whose case is under investigation.

The Tribunal is bound to enquire into a case represented by an Executive Council. If representation proceeds from some other source the Tribunal has discretion as to whether an enquiry should be held. The Tribunal, if satisfied that continued inclusion would in the case be prejudicial, must direct the Executive Council concerned to remove the name. An appeal shall lie to the Minister from this direction.

43. If the Minister after enquiry finds that the medical, pharmaceutical or dental services in any area are inadequate he has powers to make or authorise changes for the better.

48. The Minister may enter into arrangements with university and medical and dental schools for the provision of courses which may be attended by persons giving service under the Act. He may make payments towards the costs, with the approval of the Treasury.

49. In this section certain functions of the Board of Control, specified in the eighth schedule to the Act, are transferred to the Minister.

57. When the Minister is of opinion, on complaint or otherwise, that certain bodies formed by the Act have failed to carry out their appropriate functions he may after enquiry make an Order declaring them to be in default. Thereupon the members of the body must forthwith vacate office, so that new members may be appointed in due course. If the body in default is a Local Health Authority the Order will direct the members to better ways.

EDUCATION (SCOTLAND) ACT, 1946.

This Act consolidates the enactments relating to education in Scotland from the Education (Scotland) Act of 1872 down to the time of writing. It varies from what is said above[1] on the Education (Scotland) Act, 1945, in the matter of school age.

DEFENCE (GENERAL) REGULATIONS, 1935.

Regulation 33B ceased to have effect on 31st December, 1947.

MEDICO-SOCIAL PROBLEMS OF THE AGED

Not least among recent developments in social medicine has been a quickening of public and medical interest in geriatrics. Already several important monographs on the subject have appeared, and a practical approach has been made by the Nuffield Trust through its National Corporation for the Care of Old People. The Report of a special Committee of the British Medical Association, dated 1947, and entitled *The Care and Treatment of the Elderly and Infirm,* offers a number of practical suggestions for the solution of the numerous problems connected with old age, including classification, housing, medical service, residential homes and geriatric research units. Data now accumulating from medico-social surveys make it abundantly clear how grim is the plight of many aged persons, and point to the urgent need for concerted action on a national scale. The necessity for such action is now the more pressing in view of the imminent dissolution of 'public assistance' and of the consequent transfer of arrangements for the care of the chronic sick to the Regional Hospital Boards.

The problem of the aged presents five main aspects, each of which will require intensive study before a final and long-term solution of the whole is possible. The separate phases of the problem may conveniently be discussed under the heads of Ascertainment, Treatment, Home Care, Research and Administration.

It is well known that many old persons live, often alone, in conditions of penury, friendless and without relatives; and it may be presumed that there are many more hitherto undiscovered. Administrative machinery for the seeking out of such cases must form an integral part of any scheme for the alleviation of distress in the aged, whether it be medical or social. The importance of the Church and the voluntary social services in this connection can scarcely be over-rated and the fullest advantage should be taken of the specialised knowledge which these bodies possess. Pride and independence, together with an abhorrence of the charitable institution, keep many indigent aged from succour, and it is on this account necessary that the steps taken to aid them should be circumspect, with full regard for personal feelings and prejudices. The approach should be in the nature of a gesture to those who have honourably served their generation, and so have earned their leisure. The recipients must never be made to feel, as has happened all too frequently in the past, that they are but a burden upon their fellows.

It is generally agreed that hospital accommodation for chronic sickness in the aged is in many areas inadequate. It is acknowledged also that timeous hospitalisation could restore many elderly persons who from lack of such attention are doomed to end their days as incurables in the comparative cheerlessness of the public assistance ward. There is thus a clamant need for more specialised accommodation in the shape of geriatric units for the aged sick, where in bright wards their ailments could be scientifically studied and where physiotherapy and other methods of rehabilitation could play their respective parts in restoring the enfeebled frame to the highest level of its capacity. Statistics show that under present-day conditions some 40 per cent. of aged patients are fit to return to their homes after hospital treatment. An equivalent percentage of cases end fatally, while the remainder, approximately 20 per cent., require prolonged or permanent residence under nursing supervision. It must be a part of hospital policy in the future, by means of an improved sickness service for the aged, to increase the number of those who return to their homes at least partially restored, while at the same time providing suitable annexes in which the incurable patient may have the burden of sickness lightened to the limit of medical powers. It is essential that there should be accommodation for aged psychiatric cases. Not less important than the hospital itself is the convalescent home for the prolonged recuperation which is usually necessary in the elderly. Here there is scope for handcrafts such as weaving, rug making and the like to encourage the active mind which is so beneficial in the declining years. A well trained nursing personnel is a *sine qua non* of any satisfactory sickness service for the aged; and the attention of young medical graduates should be directed to geriatrics which is likely to become a specialism in the years to be. Only by the creation of an expert panel can the hope of an efficient health service for the elderly be realised.

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[1] *vide* page 44.

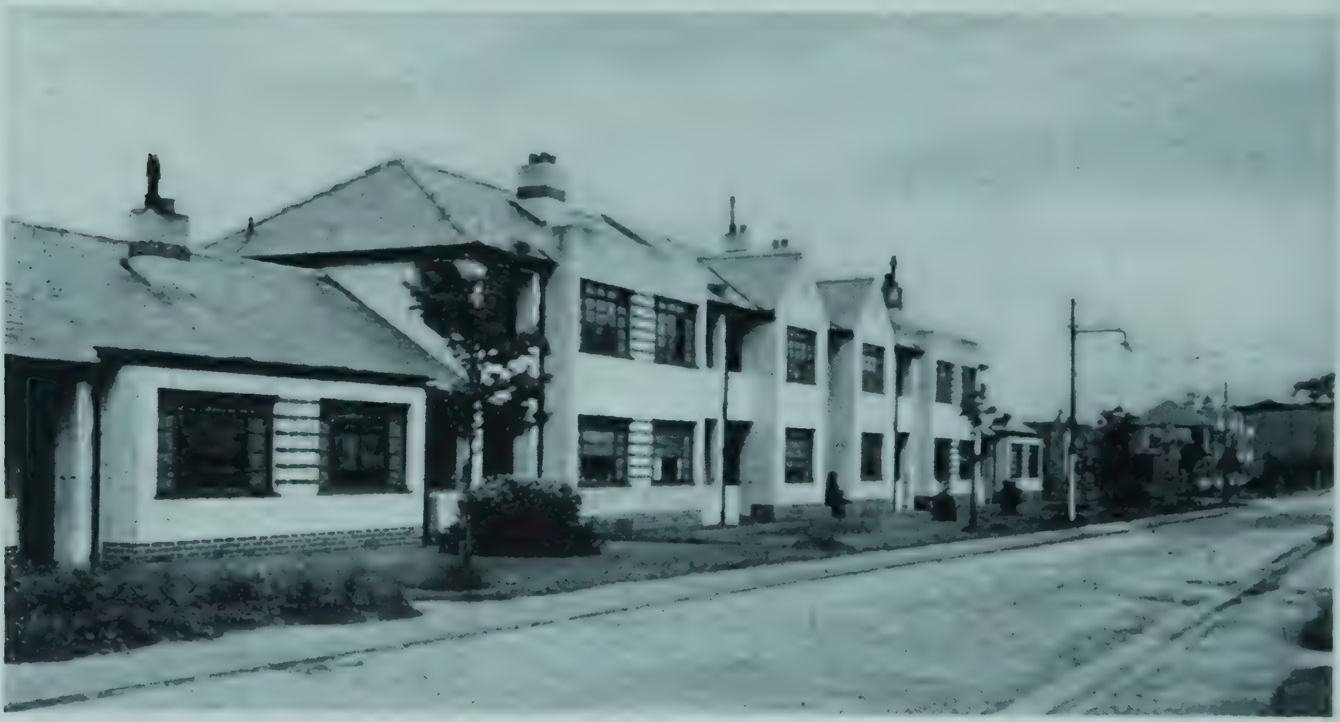
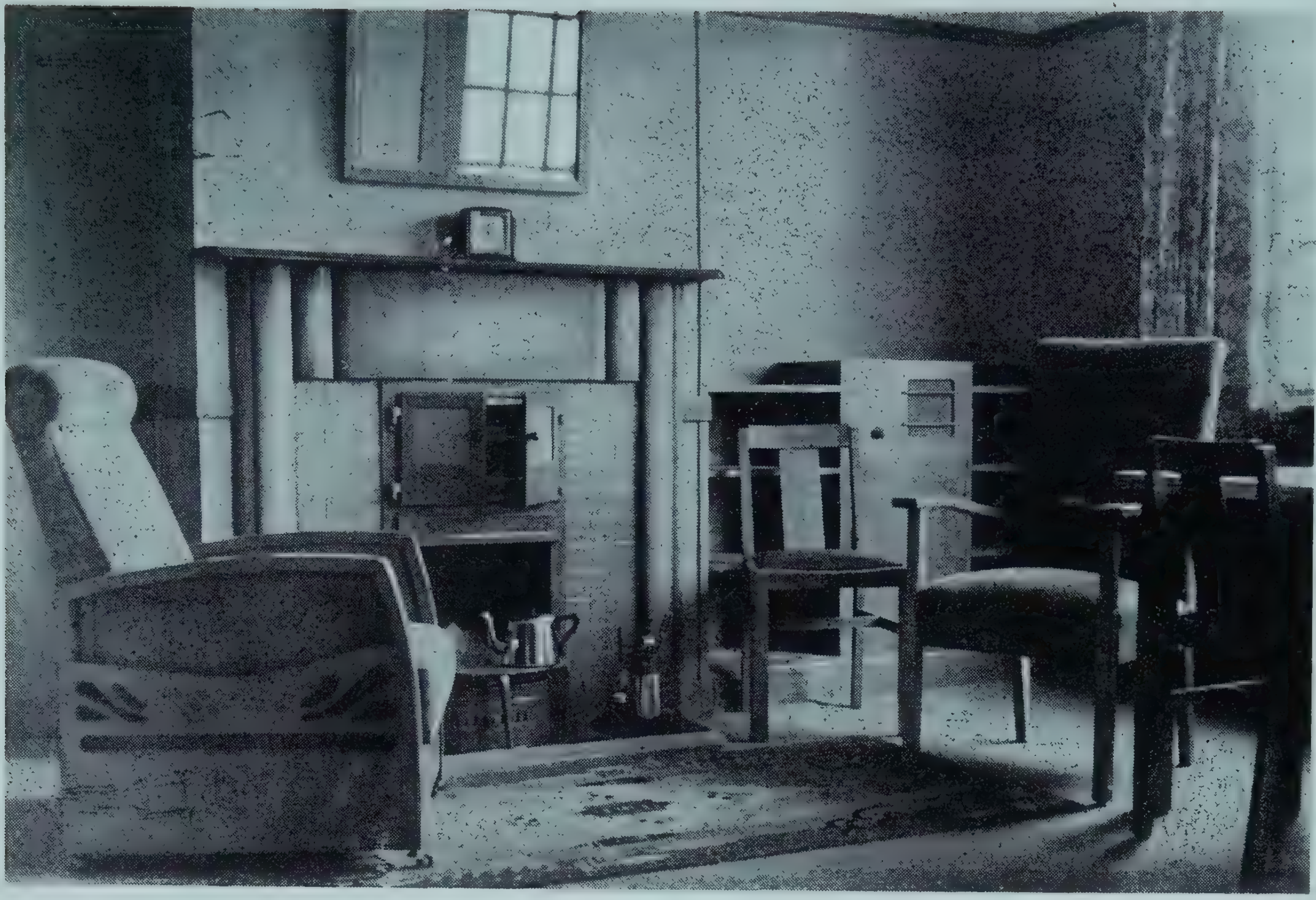
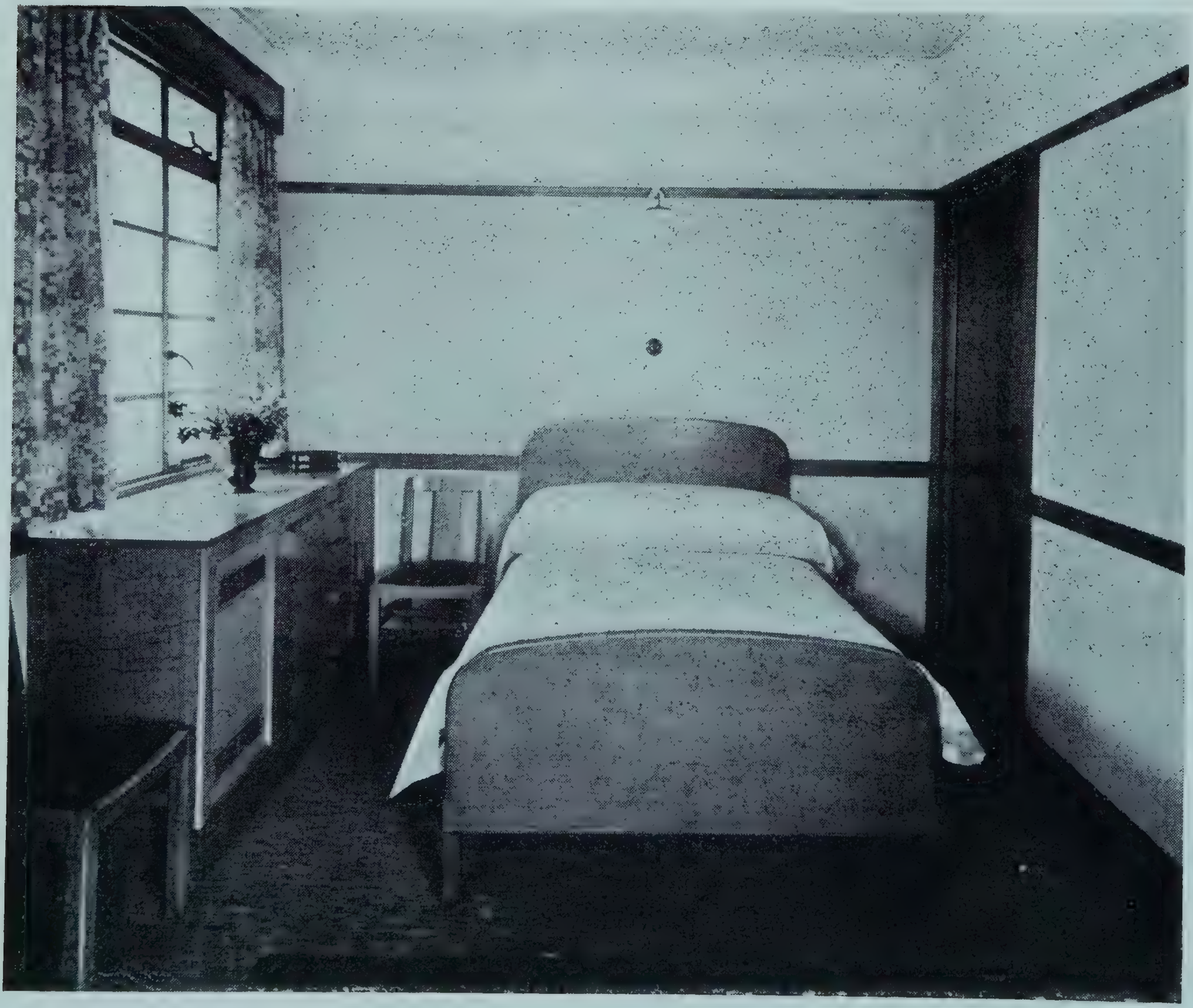


Fig. 211.—Crookston Cottage Homes — General View.

The position of many aged persons who live alone in these days



Living Room.



Bedroom.

Fig. 212.—Crookston Cottage Homes — Interior Views.

is often precarious. Finances are frequently low, sometimes dangerously so. Even in those of independent means, enfeeblement makes shopping, cooking, and housework difficult if not impossible. In poorer circles the aged person has not infrequently no home, and relies for shelter upon the casual ward or the common lodging house. It is little wonder in these circumstances that ill health in time supervenes and decrepitude is hastened. An old person is not always well received in the home of a married son or daughter; nor is such a course always convenient even when a welcome is extended. As a solution of the domestic difficulties created by the existence of elderly relatives there is the strongest possible case for bright residential quarters which have nothing of the 'institution' in their design or management. Such establishments may take the form of cottage homes, as exemplified by the now famous Crookston undertaking at Glasgow (Figs. 211 and 212) or service flats. The difference between the two systems is largely one of lay-out. Individual privacy is offered on either plan, and the provision of domestic service, cooked meals and medical attention promotes peace of mind. Central common rooms with quiet games, bowling greens, gardens and sun verandahs offer leisure activities within the capacity of the occupants. A vastly greater development of such schemes is required to overtake the needs of our ageing population. It is advisable that the homes should be socially graded. Some of the worst cases of poverty have been encountered in well-born individuals who, fallen on evil days, are too proud to seek assistance.

In view of the facts that the mean age at death of the population is rising, and that marked increases are being recorded in diseases such as nephritis, cardiac failure and cerebral haemorrhage, which in many cases have their beginning in middle age, an investigation of the factors causative of senescence seems to be indicated. In 1901, the returns of the Registrar General showed that the number of persons in Britain over the age of 60 totalled 2½ millions. The Beveridge Report, on the assumption that present trends will continue, estimates that persons in the age group 60 and over will exceed nine millions by 1971. Such an examination involves both laboratory research in human biology, including the histopathology of senile tissues, and an intensive observation of the process of ageing as ascertained by the serial clinical assessment of an adequate number of volunteers year by year. It is pertinent to note that such a clinical review has already begun in Baltimore. By these methods it should in time be possible to formulate standards on which to appraise fitness at a given higher age; and to secure data regarding healthy personal variation in physiological response to increasing age. Since the higher age diseases may in some cases be due to hereditary factors, more work in this field is required of the geneticist and the eugenist. The special hospital units for the aged, already noted, could, when associated with a medical school, usefully serve as centres of research in senescence, while at the same time affording facilities for scientific research and clinical study to those who intend to specialise in geriatrics.

While it seems likely that the task of organising a specialist sickness service for the aged would devolve upon the Regional Hospital Boards, the issue is as yet far from clear. In order to succeed, any scheme of the kind would require to be closely linked with an ascertainment service by which senescent changes could be detected at an early and remediable stage. Such a service could usefully be undertaken by the local health authorities, especially as the responsibility for the care of healthy aged persons will in all probability remain with the medical officer of health. The duty of ascertainment may be performed through the medium of clinics, for example, at which persons over the age of 50 could have a complete medical overhaul on request. There should be a place in such a scheme for the almoner and the health visitor, so enabling these key officials to work in collaboration with representatives of the social services. It would then be possible to classify aged persons requiring attention into three main groups; those in need of hospitalisation, those who could benefit from out-patient treatment and those who are reasonably fit but whose homes are unsatisfactory or non-existent. The provision of a 'home help' service is a necessary adjunct to the administration of the out-patient group, and it has worked well in Glasgow. Having ascertained for their area the number of old persons in distress, it would be the duty of the local health authority to ensure that their needs were speedily and permanently met.

The complex problem of the aged will be solved only when the geriatrist, the economist, the almoner, the health visitor and the social worker co-operate, under central direction, to encompass the difficulties which beset the later years. By whatever means they are to be achieved, the aims are clear. They are the fullest possible restoration to health and happiness of those whose days of service are over; and the provision for them of an environment in which physical comfort and mental tranquillity combine to give in their lives peace at eventide.

INDEX

A

Abatement notice, 128
Abattoirs, 252
Able-bodied destitute, 667
Ablution, schools, 48
Abortion, 27
Abortus fever, 513
Abstainers, 261
Acarina, order, 567
Accidents, factory, 84
Accredited milk, 239, 240
Acetone methylene blue, 308
Acetylene, lighting, 318
  tetrachloride, 97
  welding, 319
Achievement tests, 68
Achorutes, 539
Acquired immunity, 403
Actinomycosis, 437
Actinotherapy, 51
Activated carbon, 337
  dehydrocholesterol, 218
  sludge, 352, 356
Active immunity, 403
Actual increase method, 147
Acute primary pneumonia, 476
Adelie land, polar climates, 628
Administration, England and Wales, 118
  Scotland, 140
Adopted children, 41
Adoption of Children Act, 41
Adoption of Children (Regulation) Act, 41
Adult defectives, 75
Adulteration, milk, 232
Adult serum, 473
Advanced tuberculosis, 254
Advice to administrators, 495
Advisory Committees, health service, 686
Advisory Committee on Tuberculosis, 498
Aëdes aegypti, 522, 553, 555
  leucocelaenus, 522
  mosquitos, 646, 647
  variegatus, 555
Aerated waters, 269, 334
Aerosol bombs, 554
Aerosols, 434
Aëtius, 444
After-care, orthopoedics, 679
  tuberculosis, 504
After-damp, 114
Aged persons, 690
Age-group transition, 152
Agencies for nurses, 395
Agglutinins, 509, 510
Agitator fans, 299
Agricultural labourers, 164
  reservation, 382
Ague, brassfounders', 95
Air-borne noise, 588
Aircraft Regulations; Scotland, 648
  ventilation, etc., 647
Air delivery, 293
  disinfection, 434
  lock, 111
  meter, 618
  of sewers, 348
  ports, 646
Alastrim, 488
Alcohol, 583
Aleurobius farinae, 572
Alformant lamp, 428
Algae, 332
Algicides, 335
Aliens Order, 645
Alkali Regulation Act, 312
Allergy, food, 284
Almoners, 397
Alpine Air, 496
Altimeter, 616
Aluminium, 188
Alumino ferric, 352
Alum-precipated toxoid, 448
Amaas, 488
Amanita muscaria, 279
  phalloides, 279
Amaurotic familial idiocy, 71
Amblyopia, tobacco, 584
Ambulance room, 86
Ambulances, infectious disease, 421
American Civil War, 492
  ship cockroach, 540
Ammonia, 101
  in water, 329
Amoebic dysentery, 449
Anatoxin, 448
Anderson T., sulphonamides, 458
André, Nicolas, 676
Aneroid barometer, 613
Aneurin, 220

Anglican Clergy, 163, 166
Angoumois moth, 545
Anguillulina, 271
  of wheat, 262
Aniline, 95
Ankylostoma duodenale, 460, 533
Ankylostomiasis, 460
  miners, 115
Anobiidae, family, 549
Anobium punctatum, 549
Anopheles bifurcatus, 553
  maculipennis, 553
Anopheline mosquitos, 553
Anoplura, 541
Antelope, 495
Anthomyidae, 558
Anthracite stove, 302
Anthracosis, 115
Anthrax, 101
  Order, 103
Anti-amaryl aerodromes, 647
Anti-dermatitis vitamin, 221
Antidote, rabies, 462
Antilles, 522
Antimony, 91
  in food, 283
  trioxide, 283
Anti-mosquito campaign, 553
Anti-plague serum, 475
Anti-rabic institute, 462
Antiscorbutics Order, 269
Antisepsis, 426
Aphaniptera, 563
Aphasia, 56
Apidae, 566
Appert, N., 274
Apples, 266
Apprentice Act, 4
Approved Societies, 682
A.P.T., 448
Arabia, 400
Arachnida Class, 567
Arc Lamp, 317
Araneida, Order, 567
Arcon bungalow, 376
Arctic exploration, food, 212
Argasidae, 568
Argas persicus, 568
Ariboflavinosis, 221
Arithlog ruling, 197, 198
Arithmetical increase method, 148
  ruling, 197
Armadillo, 496
Arosa, 637
Arriving Aircraft, 648
Arrowroot, 266
Arsenical poisoning, 91, 270
Arsenic in food, 283
Arseniuretted hydrogen, 99
Arsine, 99
Arterio-sclerosis, 587
Artesian wells, 324
Arthropoda, 537
Articles, infective, 420
Artificial cream, 247
  lighting, 316
  pneumothorax, 501
  ventilation, 298
Asbestosis, 107
Ascariasis, 533
Ascaris lumbricoides, 531, 532
  suilla, 533
Asclepius, 1
Ascorbic acid, 223, 487
Ashpit, 342
Asiatic liver fluke, 524
  lung fluke, 525
  scrub typhus, 513, 569
Aspect, houses, 364
Aspergillus, 263, 265
Aspiration, ventilation, 295
Assistance Board, 674
Assistant nurse, 394
Atebrin, 472
Atheroma, 587
Atmospheric pollution, 308
Attainment tests, 68
Attested herds, 237
Attic sickness, 410
Atypical pneumonia, 477
Audiometer, 55
Austerlitz prisoners, 290
Australian cockroach, 540
  ' Q ' fever, 513
Autosome inheritance, 11
Avian tuberculosis, 496
Avignon, 411
A vitamin, 216
Azalea, 282

B

Bacillary dysentery, 451
Bacille Calmette Guérin, 498
Bacillus aertryck, 285
  botulinus, 286
  coli, water, 331
  denitrificans, 353
  diphtheriae, 444
  dispar, 451
  dysenteriae, 451
  enteritidis, 285
  fusiformis, 519
  leprae, 466
  mallei, 458
  Morgan No. I., 456
  paratyphosus, 511
  pertussis, 521
  proteus, OX 19, 512
  suipestifer, 285
  tuberculosis, 497
  typhosus, 508
  ureae, 353
Back-to-back houses, 295, 369
Backwardness, 53

Bacon beetle, 548
Bacterial food poisoning, 285
Bacterial infection, 399
Bactericidal mists, 434
Bacteriological tests, water, 331
Bacteriophage, 443
Bacterium tularense, 508
Bagassosis, 108
Baker's brat, 538
Baking powder, 264
Balance ventilation, 299
Balantidium coli, 453
Banana, 266
Bang's method, 237
Barcroft, J., 636
Barley, 265
Barlow's disease, 486
Barmaids, mortality, 167
Barmen, mortality, 164, 166
Barometers, 613
Barque Hecla, 413
'Barrier' protective creams, 111
Barrowmore Hall, 504
Baschurch Home, 676
Baths, 1
  sea, 583
  school, 48
  pit head, 115
  swimming, 340
Bauxite, 444
Bayer, 205, 495
B.C.G., 498
Bean, poisoning, 282
  soya, 266
'Beat' knee, 114
Beaufort scale, 619
Bed bug, 543
Bedrooms, 375
Beds, hospitals, 384
  isolation, 389, 390
  maternity, 27
  sanatoria, 392
  spacing, 405
Beef, measly, 528
Bee or wasp sting, 566
Beers, 270
Beetles, 547
Beggiatoa, 322, 361
Bel, 588
Bendien, 439
'Bends,' 111
Benefits, industrial injuries, 683
  national health insurance, 680
Ben Vorlich, 638
Benign tertian malaria, 468
Benzene, 95
Benzyl benzoate, 571
Beri beri, 437
Berkefeld filter, 340
Berkshire bread scale, 663
Besredka's vaccine, 443
Beverages, 268
Beveridge, Sir W., 153
Bicycle sheds, 45
Bight of Biafra, 562
Bilharzia haematobia, 525
Binet and Simon, 66
Binet-Stanford scale, 67
Biniodide of mercury, 427
Bio-aeration, 356
Biological value, food, 211
Birmingham, planning, 379
Birth control, 15
  rate, 150, 156
Births, notification, 35
  registration, 150
Biskra boil, 465
Biting lice, 541
Bitter vetch, 282
Bitumen, water pipes, 325
Bituminous coal, 302
Black Assizes, 511
Blackboards, 47
Black damp, 113
  death, 2, 408, 475, 628
  fly, 556
  rat, 577, 578
  vomit, 522
Blacker, C. P., 17
Blackwater fever, 472
Blankets, disinfection, 433
Blatta orientalis, 539
Blatella germanica, 539
Bleaching powder, 336, 339, 428
Blind children, 53, 675
Blindness, prevention, 675
Blind Persons Act, 675
Blood culture, 509
Blood fluke, 526
  fluke dysentery, 453
  picture, malaria, 471
Blow fly, 560
Blown can, 277
Blue bottle, 561
Board of Control, 690
  of Trade, 644
Body louse, 511
Boiling of water, 339
Bokhara, 409
Bonding, bricks, 365
Bone-joint tuberculosis, 501
Books, infective, 420
  disinfection, 433
  school, 47
Booster injection, diphtheria, 449
Boots, 63, 585
Bora, 624
Bordet Gengou medium, 521
Borkhausenia, food moth, 545
Bossing of head, rickets, 482
Botulism, 286
Bourneville, 380
Bovine tuberculosis, 236, 237
Bowley's formula, statistics, 186

Brackish water, 326
Braille, 54
Brandy, 271
Brassfounder's Ague, 95
Bread, 264
Breadth of wards, 385
Breast feeding, 32
Breathing apparatus, industry, 483
Bretonneau, P., 508
Bricks, ventilating, 297
Brieger, L., 260
Brightlingsea, 260
Brill's disease, 512
Bristle tails, 538
British restaurants, 268
British Social Hygiene Council, 519
Broad irrigation, sewage, 354
  tapeworm, 529
Broken Hill mines, 105
Broncho-pneumonia, 477
Brougham, Lord, 683
Brownlee, J., 408
Brown rat, 578
Brucella, 513
  abortus, 238
Bruchus pisorum, 548
Bubonic plague, 475
Buchan trap, 345
Buffalo gnats, 556
Bugs, 543
Buildings, 124
  school, 45
'Bumps' or 'Bunches,' hookworm, 460
Bunnell, P., mononucleosis, 459
Bunt of wheat, 261
Burial Acts, 435
Burning, disinfection, 432
Burt scale, 67
Butter, 248
Butterfly school, 45
B_1 Vitamin, 220
B_2 Vitamin, 221
B_6 vitamin, 221
Byelaws, 120
By-passes, 379
Byssinosis, 108

C

Cadmium, 92
Caffea arabica, 269
Caffeine, 269
Caisson disease, 111
Calabar swelling, 536, 558
Calais, plague, 410
Calandra granaria, 548
Calciferol, 218
Calcium, diet, 214
Calliphora erythrocephala, 561
'Calor' gas, 303
Cambridge, ventilation, 299
Camp fever, 511
  latrines, 349
  waste, 349
Canal boats, 135
Cancer, 438
  Act, 439
Candle power, 313
Candling, 257
Candy distributor, sewage, 355
Cannes, 630
Canning, 274
Canteens, factory, 87
Captive bolt pistol, 250
Carbohydrate, 213
Carbolic acid, 427
Carbon bisulphide, 96
  dioxide, 99
  monoxide, 99
Carborundum, 106
Card, medical record, 50
Cardium edule, 260
Careers Councils, 65
Care of blind, 675
Care of cripples, 676
Caribbean sea, 521
Carotene, 216
Carriers, bacterial, 400
  diphtheria, 449
  typhoid, 510
Carriers handling food, 425
  in Scotland, 425
Carrier state, 400
Carrot, 266
Cartons, milk, 244
Case-making clothes moth, 545
Casoni test, 529
Casting pen, 251
Castlereagh, Lord, 663
Casual ward, 668
Catchment area, 321
Cathcart, E. P., 89
Cathcart-Murray scale, diet, 226
Cellulitis, 114
Cellulose, 213
Celsus, 1
Cement, 365
Cemeteries, 435
Census, 146
  Act, 146
  schedule, 146
Central African relapsing fever, 569
Central Council for Health Education, 590
  of Physical Recreation, 587
  death rates, 170
  departments, 119
  hall school, 45
  heating, 304
  Midwives Board, 20
  rehousing, 372
Ceratophyllus fascinatus, 565
Cereals, 261

Cerebrospinal fever, 415, 439
Cerro de Pasco, 636
Certification of Nurses, 394
Certified institution, 76
  milk, 241
Cerussite, 92
Cestoda, 527
Chadwick, E., 4
Chagas's disease, 495, 543
Chalets, 392
Chamberlain, Mr., 665
Chancre, 514
Changes, air, 294
Chaplin, Mr., 666
Charles' law, 296
Charles II, 661
Charles V, 11
Charwomen, mortality, 167
Cheese, 249
  mite, 572
Cheilosis, 221
Chelmsford, 238
Chemical cooker, canned food, 278
  poisons, food, 284
  preservatives, food, 276
  privies, aircraft, 647
  tests, water, 329
Chenopodium, oil, 460
Cheyne-Stokes respiration, 459
Chicago, poisoning, 274
Chicken pox, 441, 442
Chicory, 269
  ducts, 263
Chilblains, 61
Child Care Reserve, 37
Child guidance, 78
  protection, 41
Children and Young Persons Act, 41
Children, destitute, 669
  employment, 41
Children's allowances, 153
Chilling, food, 273
Chimneys, 297
Chimney sweeps, mortality, 163, 164
Chinook, 625
Chironomidae, 555
Chi-square, statistics, 208
Chloracne, 98, 100
Chloramine, 336
Chloramin-T, 441
Chlorinated lime, 336, 428
  naphthalene, 98
Chlorination, mains, 339
  sewage, 357
  swimming baths, 341
  water, 335
Chlorine, 100
Chloros, 339
Chocolate, 269
Choice of employment, 65
Cholecystectomy, 510
Cholera, 326, 408, 443, 652
Cholerine, 443
Chorea, 480
Chorioptic mange, 572
Chrome ulceration, 103
Chromosomes, 7, 8
Chronic alcoholism, 583
  phthisis, 499
Chrysomyia bezziana, 563
  macellaria, 563
Chrysops discalis, 508, 536
Cider, 270
Cimex lectularius, 543
Cinematograph, 601
Cisternal puncture, 440
Citrus fruits, 269
Cladosporum, mould, 273
Class-rooms, 47
Claviceps purpurea, 262, 265, 457
Clayton apparatus, 642
Clean milk, 233
Cleansing Order, 577
  persons, 576
  premises, 576
  procedure, 577
  station, 577
Clearance Order, 369
Cleg, 557
Clergy, mortality, 163
Climate, 627
Clinic, infant, 33
  prenatal, 22
  pre-school, 36
  psychiatric, 78, 79
  school, 53
  tuberculosis, 501
  venereal disease, 517
Cloakrooms, 49
Clonorchis sinensis, 524
Closing Order, 369
Clostridium tetani, 492
  welchii, 334
Closure, school, 58
Clothing, adults, 584
  children, 61
Coal fire, 301
  gas, warming, 302
  gas, lighting, 318
  mines, 113
Coal tar colours, food, 277
Cobalt, dietary, 216
Coccidiosis, 256
Cockles, 260
Cockroach, 539
Cocoa, 269
Cod liver oil, vitamin A, 218
Coeliac disease, 215
Coffee, 269
Cohn's test, print, 47
Coke, 302, 303
Cold air douches, 83
  bath, 317
  cathode lamp, 317

Cold stroke, 628
Coleoptera, 547
Collagen, 223
Collembola, 539
Colours in food, 277
Colour of water, 326
Combinaison hermétique, 476, 512
Combined death rates, 162
  system, sewage, 343
Commissioners, 1834, 663
Common cold, 462
  gnat, 554
  lodging houses, 134
Communal feeding, 268
  laundry, 378
Community, planning, 380, 381
  centre, 374
  hygiene, 5
  immunisation, 426
  restaurant, flats, 375
Comparative fertility, 150
  mortality figure, 167
Compensation, loss of practice, 688
  special schemes, industry, 116
  workmen's, 115
Competitive sports, 587
Compressed air illness, 111
Compulsory notification, V.D., 516
  school age, 43, 44
  sterilisation, 16
  vaccination, 490, 491
Concrete, 365
Concurrent disinfection, 432
Condensation damp, 368
Condensed milk, 245
Conditioning, air, 298
Confectionary filling, 248
Confidential treatment, V.D., 517
Confluent smallpox, 488
Conorhinus megistus, 496, 543
Conscience clause, vaccination, 490, 491
Conservancy system, sewage, 348
Constant system, water, 325
Consultation, specialist, fevers, 416
Contact, 33B, 517
Contact insecticides, 573
Contacts, 424
Continental climates, 635
Contraception, 15, 23
Contributory pensions, 673
Control of defectives, 74
  of food, 228
  of rats, 579
Controlled tipping, refuse, 342
Convalescent serum, 473
Conway, 260
Cooking, 267
Cooled hospital ward, 633
Coolie itch, 460
Cooper's disc, 297
Copper, dietary, 216
Cork lining, buildings, 375
Corn flour, 265
Corrected and adjusted death rate, 158
Corrected death rate, 158
Correction, orthopaedics, 676-680
Correlation, 202
Corry Mann, milk, 231, 245
Corynebacterium diphtheriae, 444
Coryza, infective, 462
Cottages, 373
Cotton, 61, 584, 585
Council for Care of Cripples, 677
  for Mental Health, 79
Counties of cities, 141
Country planning, post-war, 382
County Kerry, 308
Courses in mental disease, 79
  in public health, 656
Cowes and Ryde, 640
Cow shed, 233
Crab louse, 542
Crabs, 258
Cranial myiases, 563
Cream, 247
Crèche, 36
Creeping eruption, 535
Creeping myiasis, 563
Cremation Act, 435
  precautions, 435
Cresol, 427
Cretinism, 73, 455
Crew's quarters, 644
Crimean War, 411, 492
Cripple children, 57
Crippling, 57, 676
Critical temperature, industry, 293
Cromwell, Oliver, 466
Cross-infection, 422
  ventilation, 406
Croydon, 326
Cruchet, R., 454
Crude death rate, 157
Cruelty to children, 41
Crusting, smallpox, 489
Cuba, 413
Cubic feet of space, 82, 294
Cubicle block, 388
Cubicles, isolation, 389, 390
Culex fatigans, 553
  pipiens, 553, 554
Culicidae, 551
Culicine mosquitos, 553
Culicoides, 556
Cumulative frequency, 188
  curve, 187
Cup anemometer, 618
Current steam, disinfection, 430
Currie, J., 2
Curve of epidemic, 407
  of error, 192
Customs, aerodrome, 650

Cutlery grinders, 165
C vitamin, 223
Cyanogas, 643
Cyanogen, 100
Cyanosorb, I.C.I., 642
Cyclone, 622
Cyclones, 621
Cyclops, 536
Cyllin, 427
Cysticerci, 528
Cyst passers, 451
Cysts, amoebic, 450
  hydatid, 529
  retention, 451

D

Daily requirements, food, 225
Dairy construction, 233
  management, 234
Dairyman's itch, 572
Dakar, Syrian immigrants, 413
Dakin's solution 428
Damaged meat, 253
Damp, housing 366
Damp-proof course, 367
Danysz virus, 580
Dark rays, 301
Davis submersible chamber, 112
Davos, 637
Daylight factor, 315
  lamp, 318
Day nursery, 36, 38
D.D.T., 540, 544, 551, 561, 573
Dead body, dangerous, 420
  hospital, 421
  infective, 420
Deafness, 55
Death in hospital, 421
Death rate, corrected, 158
  corrected and adjusted, 158
  crude, 157
  recorded, 158
  standardised, 158
  uncorrected, 157
Death rates, 157
  registration, 157
Death watch beetle, 549
Decibel, 588
Decompression chamber, 112
Deep sea diving, 112
Deep well, 323
Deer fly, 558
Deer fly fever, 508
Defaulters, at clinics, 517
Defectives, control, 73
Defective speech, 56
Delhi boil, 465
Delinquency, post encephalitic, 455
Delivery, air, 293
Demolition Order, 369
Dengue, 443
Dental caries, 53
Dental clinic, 52
  dystrophy, 326
  fluorosis, 444
Departing aircraft, 649
Department of Health for Scotland, 140
Deratisation, 642
  exemption, 644
Derbyshire neck, 636
Dermatocentor venustus, 508, 567, 568
Dermatobia cyaniventris, 563
Dermatosis, industrial, 1~~0~~8
Dermestes lardarius, 548, 549
Dermestidae, family, 548
Derris root, 542, 543
Desert land, 631, 632
Design of dwellings, 378
Designated milks, 238
Desks, school, 48
Desquamation, 483
Destitute able-bodied, 667
  children, 669
  sick, 668
Detention in hospital, 421
Dettol, 427
Development corporation, 382
de Vilbiss spray, 463
Devonshire cream, 247
Diagnosis, 416
Dick test, 484
Dietaries, 224
Diethylene dioxide, 97
Difficult tenants, 379
Diffused daylight, 315
Diffusing units, 318
Diffusion, gases, 295
Digger wasp, 566
Digne, typhus, 411
Dioxan, 97
Diphtheria, 238, 414, 444
Diphyllobothrium latum, 529, 530
Diplococcus pneumoniae, 476
Diploma in Public Health, 656
  in social study, 397
Diptera, genera, 551
Diptera, order, 550
Direct disposal, sewage, 350
Disability, 53
Disabled persons, 90
Disabled Persons (Employment) Act, 1944, 90
Discomyces bovis, 437
  madurae, 437
Disconnecting trap, 346
Discontinuous variables, 194
Discrete smallpox, 488
Discretion in diet, 583
Disease, milk-borne, 236
  water-borne, 326
Disinfectants, 426
Disinfecting stations, 431

Disinfection, 426
  schools, 58
Disinfector, 389, 392
Disinfestation, 434
Dispensaries, poor law, 664
Dispensary, tuberculosis, 501
Disposal of the dead, 434
  refuse, 342
  sewage, 343
Distoma hepaticum, 524
Distinct, housing, 381
  heating, 375
Diving, deep sea, 112
Dobbin blower, 541
Doctor-in-charge, 19
Doctor-midwife combination, 21
Dodwell Dunning apparatus, 541
Dog tick, 513
Dolcoath mine, 534
Domestic filters, water, 339
  midwifery, 19
  smoke, 307
  soap, 427
  water purification, 339
Domiciliary assistance, 667
Dominant, heredity, 8
Don John of Austria, 11
Dormitator, top minnow, 553
Double windows, 307
Douches, cold air, 83
Dough, 264
Down spout, 344
Dracontiasis, 536
Dracunculus medinensis, 536
Drain, 345
  test, 346
Draught effect, 293
Dried Foods, 273
  -fruit moth, 547
  milk, 246
Driers, hot air, 40
Drinking fountains, 45
  water, ships, 644
Drosophila melanogaster, 13
Dry heat, 432
  kata, 291
  refuse, 342
  rot, 367
Drying, food, 273
Dual water supply, 325
Duck eggs, 257
' Duckering ' process, 103
Ducks, 256
Ducrey bacillus, 516
Dudley, S. F., 400, 412, 413
Dukes, C., 486
Dullness 53
Dum-dum fever, 465
Dundee, food poisoning, 248
Dust effects, 108
Duties of Executive Councils, 688, 689
D_2 vitamin, 218
D_3 vitamin, 218
Dwellings, design of, 378
Dysentery, amoebic, 449
  bacillary, 451
  carriers, food, 425
Dystokia, 29

E

Early purpura, 487
  roseola, 487
Earth burial, 434
East Africa, 647
East coast climate, 638
Eberthella typhi, 508
E.B.I., 450
Echinococcus granulosus, 258, 529
Economo, C. von, 454
Edible molluscs, 259
  mushrooms, 279
Edinburgh, New Town, 379
Education Act, 1944, 41, 42, 43, 74, 75
  tests, 68
Education (Scotland) Act, 1945, 44
Education (Scotland) Act, 1946, 690
Edward III, 660
Edward VI, 660
Effective temperature, 5
Efficiency, maternal, 32
  physical, 5
Eggs, 257
Egyptian chlorosis, 534
Elastic reserve, dietary, 213
Electoral increase method, 148
Electric accumulators, 92
  heating, 304
  wallpaper, 304
Electrical stunner, 250
Electric lamps, 316
  radiator, 303
Electro-welding, 319
Electron microscope, 401
Elephantiasis, 535
Ellison's conical brick, 297
El Tor, 400
Emergency, obstetrical, 20
Emery, 106
Emetine, 450
  bismuth iodide, 450
Emission meter, smoke, 310
Empire loyalists, 632
  Rheumatism Council, 482
Employment of children, 41
Empusa muscae, 559
Emsworth, 259
Encephalitis lethargica, 454
  post-vaccinal, 491
Encephalopathy, 92
Endemic goitre, 455
  haematuria, 526
  haemoptysis, 525

Endemic infection, 405
  prevalence, 405
  typhus, 512
Endotoxins, 399
Energy value, 226
Entamoeba histolytica, 450
Enteric carriers, 425
Enteritis, epidemic, 456
Enterobius vermicularis, 533
Enuresis, 63
Environment, 14
Enzootic infection, 405
Enzootic diseases, 252
Eosinophilia, 523, 529, 532, 537
Ephestia kühniella, 545, 547
Epidemic disease, 405
  catarrhal jaundice, 456
  curve, 407
  enteritis, 456
  hepatitis, 415
Epidemiology, 407
Epilepsy, 57, 73
Epitheliomatous ulceration, 104
Epizootic infection, 405
Equatorial zone, 631
Equivalent temperature, 292
Erasistratus, 1
Ergot, 265
Ergotism, 457
Erysipelas, 457
Espundia, 465
Essence of mirbane, 95
Essex, dental fluorosis, 444
Estimates of population, 147
Ethyl petrol, 93
Eugenics, 14
  Society, 16
Eupatheoscope, 292
Eurydice, H.M.S., 624
Eusol, 428
Evaporated milk, 246
Examination, periodic health, 3
Examining surgeon, 113
Excess lime, 337
Exclusion from school, 58, 423
Excreta culture, 510
Executive Councils, health service, 688
Exercise, 586
Exhaustion, heat, 459
Exhaust ventilation, 298
Exhibitions, health, 602
Exogenous mental defect, 73
Exophthalmic goitre, 456
Exotoxins, 399
Expectant mothers, 20, 227
Expectation of life, 168, 169
Extraction of guinea worm, 537
  of wheat, 264
Extramural welfare, 87
Eyam in Derbyshire, 411
Eyes of infants, 30

F

Factory Act, 81
Factory definition, 81
  Department, 81
  smoke, 307
Faeceal carrier, 510
Faeces, disinfection, 432
Falkland Islands, 637
Family Allowances Act, 1945, 153
  dietary, 224
Famine fever, 479
Fannia caricularis, 558
Fans, 299
Farcy, 458
Far eastern schistosomiasis, 526
Farm colonies, 665
Faroe Isles, 408
Farr, 145, 407
Fasciola hepatica, 524
Fasciolopsis buskii, 524
Fats, 213
Fatal accidents, 84
Fatigue, industry, 88
Faucial diphtheria, 445
Faulty well, 324
Favism, 282
Feeble-minded persons, 70
Felix vaccine, 511
Ferrosilicon, 99
Ferrozone, 352
Fertility rate, 150
Fevers, air ports, 646
Fibrositis, 481
Fiddian distributor, 355
Fiducial point, 615
Field work, water analysis, 331
Fièvre boutonneuse, 512
Fiji, measles, 408
Filaria diurna, 536
  nocturna, 535
Filariasis, 535
File cutters, 163, 164
Filter-passing viruses, 401
Filthy or verminous states, 576
  premises, 126
Filtration, sewage, 355
  water, 335, 336
Finsen light, 502
Fire damp, 113
  escapes, factories, 84
  grate, 301
First aid, factories, 84
First World War, 411, 492, 510
Fish, 257
  poisoning, 282
  tapeworm, 529
Fisher, R. A., 209
Fitness for employment, 85
  physical, 5
Fixed virus, 462
Fixtures, 343

Flame-sprayed lamp, 318
Flannelette, 62, 585
Flashings, buildings, 368
Flash point, 318
Flats, 373
Flatted properties, 372, 374
Flax heckling, 108
Fleas, 563
Flea disinfestation, 566
Fleming and Florey, 419
Flexner dysentery, 451
Floor area, 295
Floors, 366
Flounders, 258
Flour, 261
  beetle, 548
  mite, 572
  moth, 547
Flowing wells, 324
Fluorescein, 322
Fluorosis, dental, 444
Fly prevalence, 406
Fogs, 307
Föhn, 625
Folic acid, 222, 634
Folin's reagent, 245
Food, 211
  allergy, 284
  cans, 275
  cargoes and HCN, 284
  control, 228
  imported, 644
  poisoning, 279
  preservation, 272
  principles, 211
  purity, 229
  sampling, 229
  seizure, 228
  soundness, 228
  stores, 287
Food and Drugs Act, 228
Food and Drugs (Adulteration) Act, 229
Foot and mouth disease, 458
Foot-Candle. 314
  mycosis, 341
  wear, 585
Footing of wall, 365
Forced landing, aircraft, 650
Free milk, 230
Ford Robertson. W. M., 514
Forest yaws, 465
Formaldehyde, chamber, 428
Formalin, 428
Formol toxoid, 448
Form V15, travelling card, 517
Fortified wines, 270
Fortin barometer, 615
Fort William, Calcutta, 290
Foster children, 42
Fouadin, 514
Fourth disease, 486
Fowl tick, 568
Fowls, 256
Fracastoro, 511
Framboesia, 521
Franco-German war, 492
Free treatment, V.D., 516
French Riviera, 630
Frequency curve, 186
  polygon, 187, 188
Freezing, food, 273
Friedreich's ataxia, 12
Frostbite, 628
Fuel, smokeless, 311
  store, 368
Fugu, 282
Fulham Power Station, 310
Fume poisoning, 95
Fumes, nitrous, 96
Fumigation, rooms, 428
  vans, 544
Furniture beetle, 549
  mite, 572

G

Gadflies, 557
Galen, 676
Galena, 92
Galton, Sir F., Quincunx, 189
Gambian trypanosomiasis, 494
Gambusia, minnow, 553
Gammexane, 540, 544, 554. 561, 573
  smoke, 550
  spray, 574
Ganges, cholera, 443
Ganister, 106
Gaol fever, 511
Garchey system, 358, 359
Gaseous poisons, 99
Gas fire, 302
  storage, food, 274
Gassing, industry, 99
Gastro intestinal anthrax, 103
Gauvain, Sir H., 640
Geese, 256
General hospitals, 384
  Medical Council, 39
  Nursing Council, 394
Genes, 7
Genetics, 7
Gentle asking, poor law, 660
Genoa, plague, 410
Genuine food, 229
  milk, 232
George I, 662
George III, 662
German measles, 458
Germicidal temperatures, 431
Germinal defects, 71
Giardia intestinalis, 453
Giardiasis, 453

Gilbert Act, 662
Gin, 271
Ginger Ale, 269
  paralysis, 284
Girls' hostels, 77
Glanders, 485
Glandular fever, 459
Glare, 318
Glasgow, fog, 307
Glass containers, food, 278
Glaze; pottery, 92
Glazing, eggs, 273
Globe fish, 282
  thermometer, 292
Globulin of serum, 404
Glossina, 495, 561
Glossina morsitans, 561
  palpalis, 561
  tachinoides, 561
Glover, J. A., 405
Gluten, 264
Glyciphagus, 573
  domesticus, 572
Gnat, 553
Goddard Form Board, 68
Goitre, 455, 636
Gonorrhoea, 30, 515
Goodenough Committee, 656
Good meat, 249
Gordon test, 488
Gout, 587
Government lymph, 491
Gracious landscapes, planning, 382
Grain, weevil, 548
Granada, 410
Grancher system, 504
Graphs, statistics, 183
Grasse, 630
Graunt, J., 145
Greater London, 380
Great Lakes, 362
Greece, dengue, 444
Green bottle, 561
Greenwich Naval School, 412
Greenwood, M., 413
Grinders, mortality, 164
Grit, atmospheric, 307
  settlement, sewage, 351
Grocer's itch, 572
Gross Reproduction Rate, 151
Ground damp, 366
  itch, 460
  squirrel, 368, 508
  water, 322
Group tests, 68
Guardian, 76
Guardianship, 77
Guinea worm, 536
Gunshot wounds, 425, 492
Guy de Chauliac, 411
Gymnasium, medical, 58
  schools, 49

H

Haemoglobin, 215
Haematopota pluvialis, 557
Haemophilia, 10, 13
Haemophilus influenza, 464
  pertussis, 521
Haemoptysis, 499
Haffkine's vaccine, 443, 476
Haff sickness, 282
H agglutinins, 509
Haldane, J. B. S., 11
Halibut liver oil, rickets, 482
Halteres, 551
Hamburgh, 326
Hamster, 508
Hand rails, 368
Hanway, Sir Joseph, 662
Hapsburg lip, 11
Hardness, water, 327
Hard of hearing, 55
Hard ticks, 567
Hares, 256
Harmattan, 625
Harrison, L. W., 515
Harvest bug, 569
Harvey, W., 4
Hat pegs, 49
Haussmann, G. E., 379
Hawkers, 167
Hayling Island, 640
Head and tailing, 405
Head louse, 542
Health and morals of Apprentices Act, 4
Health centres, 687
  Committees, 687
  Organisations, 687, 688
  provisions, 687
Health education, 590
  in schools, 593
  propaganda, 611
Health visitors, 140
Health weeks, 606
Hearth-money, 661
Heat stroke, 459, 632
Heat treated milk, 242
Hecla, barque, 413
Height of rooms, 295
Heliotherapy, 498
Helminthes, 523
Hemiptera, 543
Hepatitis, epidemic, 456
Herd immunity, 409, 412
Herds, 238-244
Heredity, 7 *et seq.*
Herring point scale, 67
Heterozygote, 8
Hetherington Committee, 397
Hewers and getters, 164
Highland Division, 408
High power lighting, 316

High temperature short time, 244
Hill, Sir L., 291
Hinckes Bird window, 297
Hippocrates, 1, 444, 496, 676
Histogram, 185
'Hiving off,' planning, 380
Hobhouse Act, 663
Hoc morbi nomen, 409
Holder method, pasteurisation, 244
Hollow wall, housing, 367
Homalomyia canicularis, 558
Home influence, 60
  isolation, 420
  treatment, tuberculosis, 501
  work, industry, 85
Homes, maternity, 393
  nursing, 393
Homing, 265
Homogenised milk, 247
Homozygote, 8
Honey, 272
  poisoning, 282
Hookworm, 533
  disease, 460
Hopper window, 297
Hop pickers, 138
Horse bite, 492
  flesh, 255
  latitudes, 630
  serum, 404
  sickness, 495
Hortvet test, milk, 232
Hospital almoners, 397
  bed spacing, 405
  domestic staff, 397
  Endowments Fund, 686
  isolation, 421
  Management Committee, 687
  orthopoedic, 676
  schools, 678
  workshops, 679
Hospitals, 384
Hostels for defectives, 77
Hot air heating, 306
  cathode lamps, 316
  meals, 64
  water heating, 304
House construction, 365
  fly, 558
  interiors, 368
  mouse, 580
  of Commons, 299
  of Congress, 299
  pipes, 343
Housing, 364
  Act, 369, 370
  Advisory Committee, Scotland, 375
  density, 365
  factor, statistics, 148
  (Scotland) Acts, 370
  Town Planning, etc., Act, 370
Howard, J., 4
H.T.S.T. method, milk, 244
Humanism, 4
Humidification, 84
Humus, 356
Hunter, J., 4
Huntingdon's chorea, 11
Hydatid disease, 528
Hydnocarpus wightiana, 466
Hydrocephalus, 74
Hydrochloric acid industry, 101
Hydrocyanic acid, 642
Hydrogen sulphide, 100
  'swell' 277
Hydrophobia, 461
Hyères, 630
Hyganic process, refuse, 343
Hygeia, 1
Hymenoptera, 566
Hypertension, 587
Hypocaust, 306
Hypochlorite, 428
Hypoderma, bovis, 563

I

Ice, 334
  cream, 248
Idiots, 69
Illumination standards, 315
  units, 315
Imbeciles, 69
Imhoff tank, 352
Immigration, epidemiology, 413
  officer, 645
Immunity, 403
Immuno prophylaxis, 404, 425
Immuno therapy, 404
Imperial Chemical Industries, 573
Imported food, 644
Impotent beggars, 660
Impounding reservoir, 321
Improvers, flour, 264
Incandescent lamp, 318
Incinerators, camp, 349
Incubation period, 399
Incubator wards, 31
Index death rate, 161
Indian corn, 265
Indigenous Cholos, 636
Induced immunity, 404
  malaria, 515
Industrial disease, 101
  fatigue, 88
  Health Research Board, 90
  hygiene, 81
  nurses, 86
  poisoning, 91
Industrial rehabilitation, 90
  welfare, 85
Infant consultation clinic, 33
  death, 31
  mortality rates, 156

Infant mortality, 31
Infantile paralysis, 477
  scurvy, 486
Infected houses, 434
  premises, penalties, 434
  ships, 641
Infection, 399
  schools, 58
Infectious disease, canal boats, 136
Infectious disease, notification, 417, 418
Infectious diseases, regulations, 417, 418
  persons, 420
  school children, 58
  seaports, 641
Infective articles, 420
  coryza, 462
  dead body, 420
  jaundice, 463
  jaundice, mines, 115
  mononucleosis, 459
  parotitis, 474
  tuberculosis, 421
Infectivity, 408
Infestation, 523
  Branch, Ministry of Agriculture, 266, 550
  mites, 550
Infesters of food, 265, 545-549
Influenza, 415, 464
  pandemic, 409
Ingrassias, J. P., 483
Inheritance, 7
Inn keepers, 164
Insanitary areas, 369
  houses, 369
  premises, 369
Insecta, orders, 538
Insecticides, 573
Inspection, houses, 370
  dairies, 235
  factories, 81
  food premises, 287, 288
Institute of Almoners, 397
Institution, certified, 76
Institutional assistance, 668
Integral frequency curve, 187, 189
Intelligence quotient, 67
  tests, 66
Intensity of infection, 402, 405
Intermittent filtration, sewage, 354
  system, water, 325
  turbidity, water, 326
International hygiene, 641
Intestinal amoebiasis, 449
  myiasis, 563
  schistosomiasis, 453
Iodine, intake, 455
  soil, 455
Iron, diet, 215
Irradiation, air, 434
  water, 338
Irritant gases, 101
Isle of Wight, 628
Isobars, 616
Isolation, 420
  block, 390
  hospitals, 389
  period, 422, 423
  policy, 422
Isotoma, 539
Isotype method, statistics, 194, 196
Italian Riviera, 630
Itch mite, 569
'Itchy leg,' horses, 572
Ixodes ricinus, 402, 568
Ixodidae, 567
Izal, 427

J

Jacksonian epilepsy, 525
James I, 466, 661
Jams, 271
Japan, fish, 258
Japanese river fever, 569
Jaundice, catarrhal, 456
  infective, 463
Jenner, E., 2, 4
Jet tube, ventilation, 82
Jewish immigrants, epidemiology, 413
  ritual slaughter, 251
Jigger flea, 565
Judicial Order, 76
Jungle yellow fever, 522
Jupille, J. B., hydrophobia, 462
Justinian, plague, 410
Jute dust, 108
Juvenile advisory bureaux, 88
  contributors, insurance, 680
  Courts, 79
  Employment Officer, 65
  rheumatism, 481

K

Kaffa, now Theodosia, 410
Kaffir pox, 488
Kahn test, 514
Kala azar, 465
Katadyn silver, 338
Kata thermometer, 291
Kathiolan, 571
Kehoe, R. A., 92, 283
Keratitis rosacea, 221
Keratomalacia, 217
Kernig's sign, 439
Kettle, E. H., silicosis, 105
Kew pattern barometer, 614, 615
Khamsin, 625
Kick plates, doors, 392

Kilmarnock, smallpox, 408
Kiln and oven men, 165
Kilt, 62
Kimteb, 557
King Edward's Hospital Fund, 389
Kitchen, hospital, 386
Knackers' yards, 251
Koch, 497
Koplik's spots, 472
Kordofan, S.E. of, 647
Krakatoa, 621
Kuczynski, R. R., 151
Kurtosis, statistics, 187
K vitamin, 220

L

Laboratory service, 416
Labrador, avitaminosis, 217
Lactose, 230
Lads' hostels, 77
Laemophloeus ferrugineus, 547
Lakes, 321
Lambliiasis, 453
Lamps, electric, 316
  paraffin, 318
Lancefield group A, 26, 483
Land reclamation, refuse, 342
  springs, 322
  treatment, sewage, 353
Larder beetle, 548
Larder, 368, 376
Large Burghs, 141
Larvicidal fish, 553
Laryngeal diphtheria, 445
Laryngismus, in rickets, 482
Lathyrism, 282
Latin races, tropics, 632
Latrines, schools, 49
  ships, 644
Laundries, infection, 420
Laurentian limestone, 455
Layout, hospital, 384
Lazaretto, 466
Lead, 92
  arsenate, 283
  in food, 283
  in water, 327
  Paint Regulations, 76
  poisoning, 92
  tetraethyl, 93
Leaflets, health, 597
League of Nations, health, 641
Least squares, statistics, 199, 201
Leave to land, ports, 645
Lederle swab, 445
Legumin, 266
Leishmaniasis, 465
Lemming fever, 508
Lemonade, 269
Lemon juice, 269
Lentil, 266
Leonine facies, 466
Leper settlement, 466
Lepidoptera, 544
Lepisma, 539
Leprosy, 466, 628
Leptomitus, fungus, 322
Leptospira icterohaemorrhagiae, 463
Leptus autumnalis, 569
Lesser house fly, 558
Letchworth, 380
Lethal genes, 13
Lethane special, 542
Lethol P, 544
Leysin, 637
Life tables, 168
Light flux, 314
Lighting, 313
  factories, 82
  methods, 317
  schools, 47, 314
  standards, 314
Light rays, 313
Likes and dislikes, 87
Lime, disinfection, 427
Lime juice, 269
Limnaea truncatula, 524
Line squall, 623, 624
Ling system, 59
Lip reading, 55
Lists, infected and suspected localities, 648
Liver abscess, 451
  fluke, 525
Liverpool cathedral, heating, 306
  virus 580
Loa loa, 536
Lobar pneumonia, 476
Lobsters, 259
Local authorities, 118, 120
  education authority, 43
  exhaust grinding, 106
Local Government Board, 665
Local Government (Scotland) Act, 1929, 141
Local Health Authority, 687
Local Medical Committees, 688
Loch Maree, 286
Lockjaw, 492
Löffler's serum, 445
Logarithmic method, statistics, 149
London Bills of Mortality, 145
London Building Act, 1894, 364
Lone Star tick, 513
Long term periodicity, epidemiology, 409
Louis IX, 410
Louping ill, 568
Louse, 541
Louvred pane, 297
Low-temperature heating, 304

Lucilia caesar, 561
  sericata, 561, 563
Lumbar puncture, 440
Lumpy jaw, 437
Lunacy Acts, 79
Lung fluke, 525
Lupus, 501
Lyddite, 96
Lymphatic varix, 535
Lymph, vaccine, 490, 491
Lysol, 427

M

McCance and Shipp, cooking, 267
McGonigle, G. C. N., rehousing, 372
Machine-skimmed milk, 245
Mackay, Helen, 231
Mackenzie spray, 429
McKinnell's ventilator, 298
Madeira, 630
Madsen, 407
Madura foot, 437
Magenta glossitis, 221
Maggots, 562
Magnesium, dietary, 215
Maid's home, hospital, 387
Maidstone, 326
Mains purification, 338
Main springs, 322
Maintenance allowance, 506
Maize, 265
Major services, 141
Malaria, 415, 466
  prophylaxis, 472
  treatment, 468
Malarial parasites, 469, 470
  syndrome, 468
Malignant pustule, 101
  tertian fever, malaria, 468
Mallein, 459
Malta fever, 513
Mammary cancer, 438
Manchester system, 357
Manchurian winter, 411
Manganese, 94
Mange, 572
Mangrove fly, 557
Mantoux test, 497
Man values, 225
Manual ability, 69
Marcus Aurelius, 408
Margarine, 248
Maritime climates, 637
  quarantine, 645
Marmite, 438
Marriage, 15, 16, 155
  rate, 157
  registration, 155
Martin-Chick test, disinfectants, 426
Masculinity, births, 150
Masons, 107
Mass iodisation, 456
  miniature radiography, 505
Matches, 96
Maternal efficiency, 32
  morbidity, 24
  mortality, 23
  mortality rates, 24
Maternity beds, 27
  nurse, 394
  Services (Scotland) Act, 1937, 21
  unit, 385
Mattresses, disinfection, 433
Maudsley Hospital, 78
Maze tests, 68
Meal moth, 546
Meals, school, 64
Mealworm, 547
Mean product, 202
Means test, 674
Measles, 472
'Measly' beef, 528
  pork, 528
Meat, 249
  control, 253
  inspection, 531
  products, 255
Mecca pilgrimage, 641
Mechanical filtration, 335
  respirator, 446, 478
  stokers, 310
Medical, climatology, 626
  inspection, schools, 49
  Officer of Health, 139
  officer, works, 86
  practice, 669
  Practice Committees, 688
  practitioners, 164, 166
  record card, schools, 50
  Research Council, 6
  Women's Federation, 586
Medicine, preventive, 2
Medin, O., 477
Medium of the Press, 594
Mediterranean fever, 513
Meinicke test, 514, 515
Meiosis, 9
Meister, J., 462
Melcombe Regis, 410
Mellanby, K., 570
Mellanby, E., 261
Mellanby, M., 261
Melbourne, Lord, 663
Mendel, G., 12
Mendelian ratio, 12, 13
Menière's disease, 12
Meningitis tuberculous, 499
Meningococcus, 440
Menstruation, 59
Mental defectives, 69
  deficiency, 69
  disorder, 77

Mental hospitals, 78, 393
 ratio, 67
 tests, 66-69
Mental Deficiency Act, 66
Mental Deficiency Acts, 74
 Committee, 75
 Treatment Act, 80
Mepacrine, 468
Merchant Navy, 646
 Seamen, mortality, 165
 Shipping Act, 269
 Shipping Acts, 644
Mercurial poisoning, 94
Mercuric chloride, 427
Mercury, 94
 vapour lamp, 316
 discharge lamp, 317
Merulius lacrimans, 367
Metal fume poisoning, 95
 grinding, 105
 grinders, mortality, 164
Metallic colour, food, 277
 poisons, 91
Metalliferous mining, 106
Metazoan parasites, 523
Meteorology, 613
Meteorological Office, 614
Methyl bromide, 98
Methylene blue test, milk, 239, 240, 243
Meuse fever, 493
 winter fog, 307
Miami, aircraft infection, 647
Mice, 580
Micrencephaly, 71
Microfilaria, 535
Microtus montebelloi, 569
Middle life, 587
Midges, 555
Midwives, 167
 Acts, 20
 Roll, 20
 Rules, 20
Milk and Dairies Orders, 235
Milk-borne disease, 236
 -blended butter, 248
 composition, 230
Milk consumption, 232
 derivatives, 245
 fat, 230, 232
 in schools, 64, 232
 Marketing Board, 64
 ration, 232
 special designations, 238-243
 (Special Designations) Orders, 238
 transport, 235
 tuberculosis, 236
Milking, 234
Milk of Lime, 428
Millbank disinfector, 432
Milled rice, 437
Milling, flour, 264
Milton, 428
Mine gases, 113
Minerals, dietary, 213
Miners' anaemia, 538
 nystagmus, 114
 welfare fund, 115
Mines, 113
Minister of Health, 118, 666
Ministry of National Insurance, 672
Mists, bactericidal, 434
Mites, 567
Mitman's paint, skin lesions, 443
Mitosis, 8
Mistral, 624
Modern flats, 374
 delousing methods, 541
 leper settlement, 466
 primary school, 46
 sanatorium, 391
Mohammedan slaughter, 251
Molluscs, 258-260
Moloney test, 448
Moments', statistics, 180
Mond gas, 303
Mongolism, 71
Monomorium, ant, 566
Mononucleosis, 459
Monsol, 427
Monsoons, 624
Montreal, milk outbreak, 238
Mooli, 557
Moorland water, 326
Moral defectives, 70
Moray Firth, 640
Morbidity, maternal, 24
Morbilli, 472
Morgan's bacillus, 451
Morons, 69
Mortality, infant, 31
 maternal, 23
 neonatal, 31
 prenatal, 29
 rates, male, 163
 rates, single women, 167
 rates, wives, 165
 table, 168
Mortar, 365
Moscow, typhus, 411
Mosquito control, 553
Mosquitos, 551
Mothercraft, 33, 34, 35
Mottled enamel, teeth, 326
Moulds in fruit, 266
Mountains, 636
Mountain sickness, 636
Mouse protection test, 522, 647
Mouth parts, mosquito, 553
Moving averages, statistics, 199, 200
Mucor, 263, 265
Mulattos, 8
Mule spinners' cancer, 104

Multi-storey flats, 374
Mumps, 473, 474
Munro Kerr, 24
Musca domestica, 558
  life stages, 559
Muscinae, 558
Mushrooms, edible, 279
  poisonous, 279
Muslim pilgrims, 460
Mus musculus, 580
Mussels, 260
Mustard, 271
Mutation, genetics, 13
Mutilla glossinae, 566
Mycobacterium leprae, 466
Mycosis, foot, 341
Myiasis, 562
Myope, 54
  schools, 54
Mytilotoxin, 260

N

Nagana, 495
Naples, typhus, 573
Nasal diphtheria, 445
Nash, J., town planning, 379
Naso-faucial diphtheria, 445
National Council for mental health, 79
National Health Insurance, 673
National Health Insurance Act, 1911, 666
National Health Service Act, 1946, 671, 685
National Institute for Psychological Research, 88
National Institute for the Deaf, 56
National Insurance Act, 1946, 672, 679
National Insurance (Industrial Injuries) Act, 682
National parks, 382
National Radium Trust, 439
National Reserve of Nurses, 396
National Smoke Abatement, 310
National Society of Day Nurseries 37
Natural immunity, 403
  lighting, 315
  ventilation, 295
  wines, 270
Necator americanus, 460, 533, 535
Necessitous blind, 675
Neglect, child, 41
Negri bodies, 462
Neighbourhood, planning, 381
Neisseria intracellularis, 440
Nematoda, 531
Neonatal deaths, 31
Neon lamps, 317
Nephritis, scarlatinal, 483
Net reproduction rate, 151
New homes, 375
Newman, ' G,' 14
New Towns Act, 382
New types, houses, 376
Niacin, 222
Nickel, carbonyl, 94
Nicotinamide, 222
Nicotine, 584
Nicotinic acid, 222
Night blindness, 486
Niptus hololeucus, 550
Nisbet, B. R., diphtheria, 449
Nitrates, water, 329
Nitrites, water, 329
Nitrobacter, 353
Nitrobenzene, 95
Nitrogen cycle, 353
  peroxide, food bleach, 264
Nitrous fumes, 96
Nodular leprosy, 466
Noise, 588
Noiseless repair, houses, 375
Non-metallic poisons, 95
Normal frequency curve, 189, 192
Norman archers, sweating sickness, 410
Norwegian itch, 570
Notifiable industrial disease, 112
Notification, births, 35
  food poisoning, 285
  industrial disease, 112
  infectious disease, 417
  measles, 418
  puerperal fever and pyrexia, 26
  whooping cough, 418
Nuffield, Lord, 676
Nuisances, 128
Nuns, mortality, 167
Nursery class, 40
  day, 36
  school, 39
Nurses, 167, 393
Nurses Act, 394
Nurses' hands, 432
  home, hospital, 387
  salaries, 396
Nurses Registration Act, 393
Nurses (Scotland) Act, 1943, 395
Nursing homes, 393
Nutrients, daily requirements, 225
Nutrition, 211
Nuts, 266, 267
Nystagmus, miners', 114

O

O agglutinins, 509
Oats, 265
Obesity, 587
Obstetrical service, 28
Obstructive buildings, 369

Occupational mortality, 163
  therapy, tuberculosis, 502
Ocean climates, 637
Odense, paratyphoid, 238
Odours, water, 326
Oecophoridae, family, 545
Offenders, probation of, 79
Offensive trades, 129
Office Internationale d'Hygiène Publique, 641
Ogive, 189
Oil dermatitis, 109
  stoves, 302
Old age pensions, 673
Old Age Pensioners Act, 1908, 666
Oleander, 282
Olympic games, 1
Oncocerca volvulus, 535
Oncocerciasis, 557
One-bed cubicles, hospital, 390
One-piece suits, vermin, 512, 568
One-pipe system, 345
Open air, 5
  displays, health, 606
  schools, 64
Open fire, 301
  space, housing, 364
Open square school, 45
Operating theatre, 385
Ophthalmia neonatorum, 30
Opossum, 508
Optimum lead, 89
Oranges, 266
Order, Judicial, 76
Organic amines, 353
Oriental smallpox, 646
  sore, 465
Ornithodorus moubata, 368, 479
  savignyi, 369
Ornithosis, 478
Oroya fever, 636
Orphans, pensions, 673
Orthopédie, 676
Orthopaedics, 676
  schemes, 677
Orthoptera, 539
Oscillations, epidemiology, 409
Osteo-arthritis, 481
Ostrea edulis, 259
Oswestry, 678
Otitis media, 484
Outbreak, milk-borne 234
Outlets, air, 297
Out-patient block, 385
Overcrowding, 369
Owens automatic air filter, 308
Oxalic acid poisoning, food, 279
Oxyuris vermicularis, 533
Oysters, 259
Ozone, water purification, 337
Ozonisation, 337

P

Pacific Coast, 409
Pail privies, 348, 349
Painting, lead hazard, 93
  of buildings, 93
Palestine, immigration, 413
Pamaquin, 472
Pandemic, 405
Panel heating, 304
Panophthalmitis, 472
Papworth, 503, 504
Paradichlorbenzene, 545
Paraffin dermatitis, 110
  oil, 318
Paraform, 428
Paragonimus westermanii, 525
Paralytic rabies, 461
Parasites, laboratory diagnosis, 574
Paratyphoid fever, 238, 414, 511
Paré, Ambroise, 676
Paris green, 553
Parkinsonian syndrome, 428
Park-ways, 381
Parozone, 428
Parrots, 478
Parsnips, 266
Partial boiling, 339
Party walls, 366
'Passage,' 408
Passages, 368
Passenger lifts, 378
Passengers' quarters, ships, 644
Pasteur, L., 3, 462
Pasteur-Chamberland filter 340
Pasteurella infection, 413
Pasteurisation, milk, 244, 270, 276
  wines, 270
Pasteurised milk, 239, 240, 241
Patch test, dermatitis, 111
  tuberculin, 497
Path of infection, 401
Paths of infection, typhoid fever, 509
Pavilion school, 45
Pay wards, 385
Pea beetle, 548
Peach, 266
Pearce, I. H., Peckham, 672
Pearson, K., statistics, 186
Peaty waters, 326
'Pea weevil,' 548
Pebble dash, 367
Peckham experiment, 671
Pectin, 272
Pediculi, 540
Pediculus capitis, 542
  corporis, 541
Pedigree schedule, 16
P.E., statistics, 194
Pellagra, 222, 474, 475
Pelletier, Camille, 462
Penicillin, 419

Penicillium, 262, 265
Penrose-Raven tests, 67
Pensions, 673
Pepper, 271
Perambulators, 373
Perflation, 295
Periodicity, 408
Periplaneta americana, 540
Peritonitis tuberculous, 501
Perry, 270
Personal hygiene, 582
Persons, cleansing, 576
  infective, 420
Pertussis, 520
  toxoid, 521
Peruvian wart, 636
Peterborough, 457
Petit mal, 57
Petroleum Act, 318
Peyer's patches, 508, 509
Pfeifferella mallei, 458
Phagocytosis, 403
Pharaoh's ant, 566
Pharmacy and Medicines Act, 27
Phenol, 427
  co-efficient, 426
Philip, Sir R., 501
Phlebotomus, 551
  genus, 465
  papatasii, 483
Phon, 588, 589
Phosphatase, 245
Phosphorus, red, 97
  white, 96
Phthirus pubis, 542
Phthisis pulmonalis, 499
Phylloquinone, 220
Physical fitness, 5
  training, 586
  schools, 59
Physio-therapeutics, 57
Physiotherapy department, 386
Physique of mothers, 28
Phytic acid, 215
Pickling, 272
Picric acid, 96
Picture tests, 68
Pigeons, 257
Pike, 282
Pine-apple, 266
Pioneer Health Centre, 671
Piroplasma bovis, 668
Pirquet, von, 497
Piscine tuberculosis, 496
Pistol, captive bolt, 250
Pittsburg, 292
Pitting, smallpox, 488
Placental extract, 473
'Place of safety,' 42, 665
Plague, 414, 475, 651, 661
Plains, 635
Planetary winds, 620
Plant poisons, 279
Plasmodium falciparum, 468
  malariae, 468
  ovale, 468
  vivax, 468
Plasmoquine, 472
Plastering, wines, 270
Plateaux, 635
Platyhelminthes, 524
Playgrounds, 45
Plenum system, ventilation, 298
Plodia interpunctella, 546, 547
Plerocercoid larva, 530
Pneumococcus, 476
Pneumonia, 476
Pneumonic plague, 475
Pneumoconiosis, 685
Pneumothorax, artificial, 501
Podura, 539
Poisoning, food, 279
  industrial, 91
  of rats, 580
Poisonous mushrooms, 279
  plants, 282
Poisons, cockroaches, 540
  rat, 580
Polar climate, 627
Polioencephalitis, 477
Poliomyelitis, 326, 414, 675
Pollution of rivers, 361
Poor Law Board, 664
  of England, 660
Popenoe, 72
Population, estimates, 147
  trend, 152
Pork, measly, 528
Portal of entrance, 402
Porteous maze, 68
Port medical officer, 641
  Sanitary Regulations, 641
Port Sunlight, 380
Positive health, 672
Post-encephalitic delinquency, 455
Posters, health, 598
Posture, 585
Post-vaccinal encephalitis, 491
Post-war, dietary, 227
  housing, 373
  planning, 380
Potassium, dietary, 214
  persulphate, 264
Potato, 266
  poisoning, 279
Potted meat, 255
Pottery trades, 92, 106
Poultry, 256
Poured cellular concrete, 376
Power stations, 310
Pozzuoli, fluorosis, 444
P.-P. vitamin, 222
Practical ability factor, 69
Practice, medical, 669

Precipitation, water supply, 335
  sewage purification, 352
Pre-fabrication, 377
Prematurity cots, 31
Premises, cleansing, 576
Prenatal death, 29
Pre-school child, 35
  clinic, 36
Preservation, food research station, 274
Preservatives, food, regulations, 278
Pressure filters, 336
  steam, disinfection, 430
  -tube anemometer, 618
  unit, 613
  variation, 616
Preston Hall, 504
Prevalence, 405
Prevention, 416
  in orthopoedics, 677
  of blindness, 54, 676
  of tuberculosis, 237
Preventive idea, 2
  medicine, 2
  packets, V.D., 517
Prickly heat, 634
Pride of craft, 88
'Primary avoidable factor,' 25
Prime movers, industry, 83
Prince Edward, 410
'Principles,' 1834, 663
Print, school books, 47
Privies, 348, 349
Probability curve, 192
Probable error, 193
Probationer, nurse, 395
Probation Officer, 79
Problems of the Aged, 690
Procercoid larva, 530
Processing, food, 275
Producer gas, 303
Proglottides, 527, 528
Prohibited colours, food, 277
Prontosil album, 26
Proof spirit, 270
Propaganda of health, 593
Properly constructed well, 323
Prophylactic vaccines, typhoid, 510
  typhus, 512
Propinquity diseases, 405
Propulsion ventilation, 298
Propylene glycol, 434
Protargol, 30
Protected spring, 322
Protective foods, 213
Protein, 211
  shock, 515
Proteus OX 2, 512, 513
  OX 19, 513
Protozoan immunity, 404
  infection, 400
Provision of clothing, 64
Prussia, vaccination, 490
Psittacosis, 478
Psoroptic mange, 572
Psychiatric clynics, 78
Psychoda, 551
  sexpunctata, 356
Psychodid vectors, 465
Psychoneurosis ward, 78
Public abattoirs, 252
  analyst, 229
  assistance, 667
  bathing, 133
Public Health Act, 1936, 120
Public health officials, 139
Public Health (Preservatives, etc., in Food) Regulations, 278
Public Health (Scotland) Act, 141
Public vaccination, 491
Public vaccinators, 490
Public wells, 131, 132
Puccinia, wheat, 262, 263
Puerperal fever, 26
  pyrexia, 26
  sepsis, 25
Pulex irritans, 564, 565
Pulses, 266
Pulverisation, refuse, 343
Pupil assistant nurse, 394
Purification mains, 338
  sewage, 350
  water, 334
Purpura, smallpox, 487
Pyralis farinalis, 546
Pyridine, 584
Pyridoxine, 221

Q

'Q' fever, 513
Quadrinucleate cyst, 450
Quarantine, 423, 424
  dogs, 462
  parrots, 478
  periods, 424
Quarrying, 107
Quartan fever, 468
Quarters, seamen's, 644
Quassia, 533
Queen Victoria, 664
Quicklime, disinfection, 427
'Quickstun,' slaughter, 251
Quincunx, Galton's, 189
Quinine, 468
Quinoxyl, 450
Quintan fever, 493
Quota, employment, 90

R

Rabbits, 256
Rabid dog, 461
Rabies, 461

Rachitic rosary, 482
Radiant energy, 301
  heating, 301, 302, 303
Radiology block, 386
Radix, statistics, 170
Raglan sleeve, 61
Rainfall, British Isles, 639
Rain water, 320
Rapallo, 630
Raspberries, frozen, 274
Rat, bite fever, 479
Rat control, 579
  damage by, 579
  fumigation ships, 642
  infections, 579
  poisons, 580
Rate of mortality, 170
Ratin, 580
Rats and Mice Destruction Act, 581
Rattus norvegicus, 578
  rattus, 577
Ray fungus, 437
Ray, M. B., 640
Rayrads, 305
Reception house, 434
Recessive, genetics, 7
Recognisance, 79
Record card, schools, 50
Recorded death rate, 158
Redevelopment areas, 369
Red rust grain beetle, 547
Refractories, industry, 106
Refrigeration, 273
Refrigerator, 273
Reftone, 588
Refuse, 342
Regional Hospital Boards, 687
Registered Adoption Society, 393
Register of nurses, 393
Registrar General, 146
Registration, births, 150
  deaths, 157
  marriages, 155
Regression, 204
Regulated tipping, refuse, 342
Regulation 33B, 517
Regulation of Municipal Corporations Act, 4
Regulations, in general, 119
  infectious disease, 417
  nurses, 394
  Port Sanitary, 641
  tuberculosis, 237
Rehabilitation, 90
  orthopoedic, 678
Rehousing, central, 372
  suburban, 372
Relapsing fever, 479
Relaxation treatment, 56
Remedies for infertility, 153
Removal to hospital, 421
Repetitive work, 89
Reproduction Rates, 151
Reservoirs, 321
Residential units, housing, 88
Rest pauses, 89
Restriction of Ribbon Development Act, 379
Retardation, 53
Retention cysts, dysentery, 451
Retreat from Moscow, 411
Return cases, 484
Rheumatism, 480
  Sub Committee, 481
Rheumatoid arthritis, 481
Rhizobium radicicola, 353
Rhodesian trypanosomiasis, 495
Rhubarb poisoning, 279
Rhynchota, 543
Ribbon building, 379
Riboflavin, 221
Rice, 265
Richard II, 2, 660
Rickets, 218, 482
Rickettsia orientalis, 569
  prowazeki, 511
  quintana, 494
  rickettsi, 513
Rideal-Walker test, 426
Ringelmann smoke charts, 308
Ring roads, 380
Risus sardonicus, 492
Ritual slaughter, 251
Rivers, 322
  pollution, 360
Rochester, N.Y., 456
Rockefeller Foundation, 522
Rocky Mountain spotted fever, 512, 568
Rogers, Sir L., 443
Roll, midwives, 20
Roof damp, 368
Roofing, 366
Rooms, disinfection, 433
  temperature, 301
Rossania, scarlet fever, 483
Rotenone, scabies, 571
Roughcast, 367
Royal College of Nursing, 86
  Commission on Sewage Disposal, 350, 360
  Commission, poor laws, 666
  Life Saving Society, 59
Rubella, 458
Rubeola, 472
Rules, midwives, 20
Rum, 271
Rushcliffe Committee, nurses, 396
Russo-Japanese War, 492
Russo-Turkish War, 411
Rust of Wheat, 261
Rye, 265
  ergot of, 457
Ryle, Professor John, 655

S

Sack disinfector, 430
Safe loading, rivers, 362
  milk, 234
Safety belt, 83
  match, 97
  provisions, factories, 83
Sago, 266
St. Andrews, dietaries, 226
Sale of Milk Regulations, 232
Salerno, 1
Salmonella group, 285
Salpingectomy, 72
Saltaire, 380
Salting, 272
Salt, iodised, 456
Sample pedigree, 18
Sampling, food, 229
  statistics, 207
  water, 328
Sanatoria, 392
Sanatorium schools, 57
Sand blasters, mortality, 165
Sand blasting, 107
  filtration, 335
  flies, 551
Sand fly fever, 483
Sandstone, industry, 105, 106
San Francisco, mussels, 260
Sanitary aerodrome, 650
  conveniences, 123, 127
  inspectors, 140
  science, 5
  wash house 431
Sanocrysin, 502
San Remo, 630
Santonin, 532
Saracen empire, 632
Sarcoptes scabiei, 569, 570
Sarcoptic mange, 572
Sarcoptidae, 569
Saturated steam, 430
Sauer vaccine, 521
Sausages, 255
Savage, Sir W. G., 275
Scabies Order, 571
Scarification test, von Pirquet, 497
Scarlatinal antitoxin, 484
Scarlet fever, 238, 483
Scarlett, Mr, 663
Scheduled diseases, industry, 115
Schick test, 446, 447, 449
Schistosoma haematobium, 525, 526
  japonicum, 526
  mansoni, 453, 526
Schistosomiasis, 526
Schmidt, 448
Schmitz bacillus, dysentery, 451
Scholastic tests, 68
School age, 43, 44
  buildings, 44, 45, 47
  children, cleansing, 576
  clinics, 53
  closure, 58
  disinfection, 58
  infection, 58
  meals, 64
  medical officer, 51
Schools, open air, 64
  special, 75
Schultz-Charlton test, 484
Sclavo's serum, 101
Scorpions, 567
Scotland, central authorities, 141
  Department of Health, 140
  local authority areas, 141
  nurses in, 395
  public health officials, 141
Scottish administration, 140
  Board of Health, milk, 231
  Council for Health Education, 590
  Milk Testing Scheme, 242
  Orthopoedic Council, 677
Screening, sewage, 351
'Screws,' diving, 111
Screw, worm flies, 563
Scrotal cancer, 104
Scurvey, 486, 627
Sea bathing, 640
  disposal, refuse, 343
  ports, 641
  voyages, 637
  water, tests, 334
Sealing of rooms, disinfection, 428
Seamen, merchant, 165
Seasons, epidemics, 406
Seats, factories, 84
Sebrell, vitamin P-P, 222
Second world war epidemiology, 414
Secretary of State, Scotland, 141
Sector diagram, statistics, 194
Sedimentation, sewage, 351
Seibert, 497
Seizure, food, 228
Selective breeding, 14
Selenium bridge, 310
Self-purification, rivers, 361
Semple, A. B., sand fly control, 551
Senegal, yellow fever, 413
Sennert, D., scarlatina, 483
Sensations of noise, 589
Sensori-deprivation, 73
Sensory motor tests, 69
Separate system, sewage, 348
Septic sore throat, 238, 486
Serbian barrel, 430
Sericite, 105
Serum disease, 404
Service pipes, water, 325
Services, health, 687
Service-trained nurse, 395

‘ Setting,’ epidemics, 410
Settlement Act, 661
Seventh Crusade, 410
Seven Years War, 411
Severity of infections, 408
Sewage, 343
  farm, 354
  filters, 355
  fungi, 322
(Sewage) purification, 350
Sewerage, 121
Sewer air, 348
  men, 348
Sewers, 347
Sex-linked inheritance, 9, 10
Sex teaching, 60
Shaftesbury, Earl of, 4
Shanklin and Sandown, 640
Shallow wells, 323
Sharp freeze, 274
Sheep maggot fly, 560
Sheffield system, sewage, 357
Shellfish, 258
Sheringham wall valve, 197
Shiga strain, dysentery, 451
Ship-breaking, 93
  rat, 577
Ships, passenger, 645
Shoes, children, 63
Shone’s ejector, sewage, 347
Shower baths, 48
Shrimps, 259
Sick, destitute, 668
  room, 432, 433
Siege of Granada, 411
  of Reading, 411
Silent reading test, 68
  spirit, 271
Silicosis and Asbestosis Medical Board, 116
Silk, 61, 584
Silver fish, 538
  katadyn, 338
  nitrate, eyes, 30
  polish, food poisoning, 284
Silvered katathermometer, 292
Simon, Sir J., 4
Simplex system, 357
Simplon tunnel, 534
Simulium, 556
  damnosum, 535, 557
Siphonaptera, 563
Siphon trap, 345
Siphunculata, 541
Sirocco, 624
Site, hospital, 384
  house, 364
Sitotroga cerealella, 545
Skewness, statistics, 186
Skimmed milk, 245
Skin-eating beetles, 548
  myiases, 563
Slaked lime, 428
Slaughter, 250
  houses, 252
  of Animals Act, 250
  of Animals (Scotland) Act, 250
Slave trade, 522
  trades, 494
Sleep, children, 63
Sleeping sickness, 494, 561
Slow sand filtration, 335
Sludge, 359
  disposal, 358
Slums, 369, 372
Small burghs, 141
Smallpox, 414, 487, 653
  hospitals, 392
  Prevention Regulations, 424
  Roman Empire, 408
Smith, Dr. Southwood, 4
Smoke, 307
  Abatement Society, 309
  emission meter, 308
  nuisance, 129
  problem, 311
  prevention, 310
  statutes, 311
Smoked foods, 273
Smokeless atmosphere, 310, 311
  fuel, 310
  bones, 311
Smoking, food, 273
Smollett, T., 2
Smoothing, 199
Smut, wheat, 261
Snellen’s types, 51
‘ Snow storm effect,’ silicosis, 105
Snow blindness, 628
Soap, 582
Social adjustment, 76
  hygiene, 519
  insurance, 672
  medicine, 655
Soda water, 269
Sodium, dietary, 214
  cyanide, food poisoning, 284
  discharge lamp, 316
Soft chancre, 516
  ticks, 568
Softening, water, 279
Soil pipe, 344
Solanin, 279
Solids, atmospheric, 307
Soluble cocoa, 269
  ‘ 220 ’ typhus, 512
Sonne carriers, 452
  strain, 451
Sonoma, mental deficiency, 72
Sorbitol, 270
Sound food, 228
  insulation, 376
Source of infection, 401
South African War, 492, 510

South American trypanosomiasis, 495
Southampton food poisoning, 259
Soya bean, 266
Spacing beds, 405, 406
Spain, epidemiology, 409
Spearman, intelligence, 66
Special aptitude tests, 69
  measles duty, 473
  schools, 75
  sorting, refuse, 343
'Special,' 384
  lethane, 544
Speech defect, 56
Speenhamland, 663
Spezia, 630
Spider beetles, 550
Spiders, 567
Spinal sign, 478
Spindle oil, hospitals, 422
Spirillum minus, 479
Spirits, 270
Spirochaetosis gallinarum, 568
  icterohaemorrhagica, 463
  rat, 579
Spoilage, food, 276
Spot map, 195
Sporadic infection, 405
Spotted gnat, 553
Spray-borne infection, 402, 405
Springs, 322
Springtails, 539
Sprue, 634
Sputum, disposal, 432
S.S. Londonderry, 290
Stable fly, 561
'Stabochlor,' 428
Staffing hospitals, 396
Staircases, schools, 48
Stammering, 56
Standard brick, 365
  error, 208
  house, 373
  milk, 241
  million, statistics, 159
  mortality ratio, 163
Standardised death rate, 158
Standardising factor, 162
Standards for effluents, 350
  milk, 232
  sewage, 350
  water 329, 330, 331
Staphylococci, food, 285
State medicine, 5
Statistics, 145
Statute of labourers, 660
Statutory nuisances, 128
Steam, heat, disinfection, 429
  heat, warming, 305
  tent, 446
Stegomyia fasciata, 553
Stenquist assembly test, 69
Sterilisation, eugenics, 72
Sterilised milk, 247
Steriliser dairy, 234
Still birth, 29
Stockton-on-Tees, 372
Stoke-on-Trent, 283
Stomoxys calcitrans, 561
Stone cutters, mortality, 164
  dressing, 107
  quarrying, 107
Storage batteries, 92
  gas, for food, 274
  water, 334
Stored food, parasites, 550
Storm water, 358
Stout, 270
Stoves, 302
Strawberries, frozen, 274
Streams, 321
Streptococcus haemolyticus, 457
  in food, 285
Streptomycin, 419, 502
Streptothrix actinomyces, 437
Strippings, milking, 230
Strong winds, clothing, 584
Student almoners, 397
  nurses, 394
Stunner, electrical, 56
Sturgeon, food poisoning, 282
Subinfective inoculation, 403
Subirrigation, 353
'Subject to be dealt with,' ment
  deficiency, 75, 76
Subsoil drainage, 364
Sub-tropical infections, 634
Suburban rehousing, 372
Sucking lice, 541
Sugar, 213
Sugaring, 272
Sugar mite, 572
Sulphanilamide 26
Sulphonamide drugs, 418 419
Sulphume, 429
Sulphur dioxide, 429, 642
Summer schools, 591
  grass, 231
Sun bathing, 640
Sunlight, 315
Sunstroke, 460
Superheated steam, 430
Supervisor, welfare, 85
Supplementary Pensions Scheme,
Surface burial, 435
  water, 320
Surgical tuberculosis, 496, 498,
  501
Surgeon examining, 113, 117
Surra, 557
Surroundings, houses, 364
Suspected ship, 641
Suspenders, 61
Swansea, yellow fever, 413
Sweating sickness, 410

Swimming baths, 57, 340
Sydenham, T., 4, 409, 472, 483
Sylvius, 496
Symmetrical curve, 191
Syphilis, 30, 415, 514
Syrian immigrants, epidemiology, 413

T

T.A.B. vaccine, 510, 511
T.A.B.T. vaccine, 493
Tabanidae, 557
Tabanus striatus, 557
Tabardillo, 512
Taeniae, 527
Taenia saginata, 528
  solium, 528
T.A.F., 448
T.A.F.T., 493
Talc industry, 107
Talks to mothers, 34
T.A.M., 449
Tangle-foot, 560
Tank waggons, milk, 235
Tannic acid, 268
Tapeworms, 527
  from dogs, 530
Tapioca, 266
Tarran bungalow, 377
Taste, water, 327, 336
Tavistock clinic, 78
Taylor Committee, nurses, 396
Tay Sachs disease, heredity, 71
‘ Tb. ’ groups, 501
T.D.E., 573
Tea, 268
  leaves, 262
Telephone operators, mortality, 166
Temperament tests, 69
Temperatures, factories, 84
Temporary patients, mental hospitals, 80
Tenebrio molitor, 547
Tenement buildings, 372
Tents, vans, sheds, 137
Terman-Merrill Forms, 67
Terminal disinfection, 433
  disinfestation, 434
Terraces, 379
Testing of ventilation, 300
‘ Test of cure ’ gonorrhoea, 516
Tests, intelligence, 66-69
  water, 329, 331
Tetanus, 492
Tetrachlorethane, 97
Tetryl, 95
Texas fever, 403
Textiles, disinfection, 433
Thames, 322
Theobaldia annulata, 553
Theobroma cacao, 269
Therapy, arsenical, 514
Therm, 303
Thermobia, 583
Thermometers, 292
Thermophilic bacteria, 276
Thiamin, 220
Thirty Years War, 411
Thoracoplasty, 502
Thread worm, 63, 532, 533
Thresh disinfector, 430
Thysanura, 538
Tick-borne fever, relapsing, 479
Tick fever, 568
Ticks, 567
Time trend, statistics, 197, 198
  diagram, 195
Tinea pellionella, moth, 545
Tineola bisselliella, moth, 544
Tin mines, 165
Tipping, refuse, 342
Title of ‘ nurse, ’ 394
Tobacco, 584
  amblyopia, 584
Tocopherol, 219
Tomato, 266
Tongue cancer, 438
Tonsillectomy in diphtheria, 449
  in rheumatism, 481
Topley, W. W., epidemiology, 413
Tornados, 624
Toronto, milk, 245
Torricellian vacuum, 613
Towels, 48
Town and Country Planning, 379
Town and Country Planning Act, 379
Toxaemia, pregnancy, 25, 30
Toxic hepatic necrosis, 97
Toxicity of insecticides, 574
Toxic jaundice, 96, 97
Toxins, 399
Toxoid-antitoxin floccules, 448
  pertussis, 521
Trachoma, 493
Trade winds, 631
Trained nurse, 394, 395
Training, physical, 674
Transferable deaths, 158
Transmigrants, aircraft, 645
Transportation, 662
Traps, drainage, 345
  rat, 580
‘ Travelling ’ card, V.D., 518
Travelling distributor, sewage, 355
Treatment of infections, 418
  in hospital, 422
  notice, 517
  of scabies, 571
Trebizond, honey poison, 282
Trematodes, 524
Trench fever, 493
  latrines, 349
  mouth, 519
Trend, births 151

Treponema morsus murium, 479
  pallidum, 514
  pertenue, 521
  vincenti, 519
Tribolium confusum, 547, 548
Tribunal, health service, 689
Trichina, 537
Trichinella spiralis, 537
Trinchiniasis, 537
Trinitrophenol, 96
T.N.T., 95
Trinitrotoluene, 95
Tri-o-cresyl phosphate, 98, 284
Triple standard, housing, 370, 373
Trismus, 492
Tristan da Cunha, 261
Trombicula akamushi, 513, 569
Trombidiidae, 569
Tropical climates, 631
  cyclones, 623
  infections, 634
  sore, 465
  splenomegaly, 465
  typhoid, 511
  typhus, 512
Trunk roads, 380, 381
Trypanosoma, 494, 495, 496
Trypanosomiasis, 494
Tschermak, von, 12
Tsetse flies, 562
  control, 561, 562
Tuberculin test, 243, 497
  milk, 239, 240, 241
Tuberculosis, 415, 628
  administration, 507
  Order, 237
  Regulations, 237
  types, 496
Tuberculous laryngitis, 501
  meningitis, 499
  peritonitis, 501
Tubers, 266
Tube wells, 323
Tubular heaters, 304
Tularaemia, 508
Tunga penetrans, 565
Tunis, 277
Turbidity, water, 326
Turkeys, 256
Turnip, 266
Tweed, 62
Two-fold correlation, 203
Typhoid fever, 237, 414, 508
  vaccine, 510
Typhus fevers, 414, 511, 562
Typical vaccination, 490
Typists, mortality, 166
Tyroglyphidae, 572

U

Ulceration, chrome, 103
  epitheliomatous, 104
Ulcerative stomatitis, 519
Ultra-violet irradiation, water, 337, 338
Uncorrected death rate, 157
Underclothing, 585
  of children, 61
Under-floor ventilation, 367
Underwood, M., 477
Undulant fevers, 513
Unemployment assistance, 674
  Insurance, 674
Unguentum Marcussen, scabies, 571
Unhealthy ship, 641
U.S.A. marriage laws, 15
Unsound food, 228, 229
Upland water, 320
Uredo, fungus, 262
Urinary carriers, typhoid, 510
Urine, disinfection, 433
Use of air, 582
  of water, 582
Uta, 465
Utilisable carcasses, 252

V

Vaccination, 489
Vaccination Acts, 490, 664
Vaccine lymph, 490
  chick embryo, 492
  typhoid, 510
  yellow fever, 522
Vacuum gully emptier, 349
  sealing, canning, 275
Valentia, 637, 638
Valiant beggars, 660
Vampire bats, 461
Vapour lamps, 316
Varicella, 441
Variola, 487
  minor, 487
Varioloid, 487
Vector infection, 402
Velvet mites, 569
Venereal disease, 514
Venereal Disease Act, 516
Venereal Diseases Regulations, 516
Venison, 255
Ventilation, 289
  factories, 82
Venturi meter, 325
Verminous aliens, 645
  persons, 126, 576
  premises, 576
  school children, 576
Vernier, 614
Vesication, smallpox, 489
Vespidae, 566
Veterinary inspector, 237
Vi agglutinin, 511
  antiserum, 511
Vibrio cholerae, 443

Vieusseux, 439
Vigilance associations, 519
Villages, 373, 382
Vincent's angina, 519
Vinegar, 271
Virgin soil, epidemiology, 408
Virulence test, diphtheria, 449
Virus immunity, 404
  infection, 401
  17 D, yellow fever, 522
Visibility, 308
Vision, 42
Vital Statistics, 145
Vitamin A, 216
  B_1, 220
  B_2, 221
  B_6, 221
  C, 223
  D, 218
  E, 219
  K, 220
  P-P, 222
Vitamins, 216
  and cooking, 267
Vitiated air, 290
Viviparity, 551
Vocational guidance, 65
  training, 90
Volhynian fever, 493
Voluntary hospitals, 384
  effort, 6
  patients, 80
  sterilisation, 72
Von Pirquet's test, 497
Vries, de, 12
V-Shaped depression, 624

W

Waiting cases, tuberculosis, 504
Wakes, 420
Walking parties, 382
Wall damp, 367
Warble fly, 563
Ward orderlies, 389, 396
  routine, 432
  units, 385
Warm bath, 582
Warming, 301
Warming rays, 301
Warranty, 229
Wash hand basins, 38, 392, 375
Wash-houses, 133
Washington, ventilation, 299
Washington Lyon disinfector, 430
Wassermann test, 514
Waste, camp, 349
  material, refuse, 342
  pipe, 344
  water, 344
Water, analysis, 329, 330
  bacteria in, 328, 329
  -borne disease, 326
  characters, 326
  distribution, 325
  gas, 303
  hardness of, 327
  in dietaries, 224
  quantity, 324
  rat, 508
  sampling, 328
  softening, 338
  supply, houses, 130, 320
  tests, 328
  use of, 1
Watercress, 267
Waterworks, 130
Wearing apparel, disinfection 433
Webbing clothes moth, 544
Weekly death rate, 158
Weight-operated air filter, 308
Weil-Felix reaction, 512, 513
Weil's disease, 115, 463
Weinberg casting pen, 251
Welfare centre, 22
  children, 59
  industrial, 85
  institutions, 23
  miners, 115
  schemes, 85
  schools, 59
  supervisor, industry, 85
Wellington, Duke of 663
Wells, 323
Welsbach burner, 318
Welwyn, 380
Wensleydale, 457
Wesley, J., 2, 4
West coast climate, 638
Westerlies, 629
Westminster, 299
West's post nasal tube, 440, 441
Wet clothing, 585
  kata, 291
Wheat, 261
  mite, 572
Whisky, 270
White lead, 93
  phosphorus, 96
  wash, 428
Whooping cough, 520
Widal reaction, 509
Wild rabbits, 508
Wilhelmshaven, 260
William III, 661
Winchester, 259
Windows, 297
Winds, 617
Windsor Lad, 14
Wind velocity, 618
Wines, 269
Winsler, 483

Wireless broadcasting, 602
Witwatersrand mines, 106
W.K., 291
Wohlfahrtia magnifica, 563
'Woman,' factories, 81
Women police, 519
Wood chuck, 568
Wood gnat, 553
Wood tick, 513
Wooden tongue, 437
Wood smoke, fish curing, 273
Wool, clothing, 584
  disinfection, 433
  sorter's disease, 103
Workhouse, 668
Workmen's compensation, 115
Workshops, sanatoria, 392
World climates, 626
World pressure regions, 616, 617
Worm nodules, 535
Worms, parasitic, 523
Wounds of gardeners, 492
Wrist drop, 92
Wuchereria bancrofti, 535

X

X chromosomes, 9
Xenophon, 282
Xenopsylla cheopis, 512, 564, 565
Xerophthalmia, 217
Xestobium rufovillosum, 549
  tesselatum, 549
X-ray photography, [illegible]
  mass miniature, 505

Y

Yangtse Valley fever, [illegible]
Yatren, 450
Yaws, 521
Y chromosomes, 9
Yellow fever, 521, 646
  inoculation centres, 647
Yellow spider beetle, 550
Yersin and Lustig, 475
Yield of stream, 321
Yorkdale No. 3, heater, 306
Young children, 74
'Young Person,' factories, 81

Z

Zeolites, 338
Zinc, 94
  in food, 283
Zoological classification, 524
Zoster, 441
Zyklon, 642

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